H10U6
6.7
7/27/07

Todd Shipyards
Sediment Operable Unit

Remedial Action Completion Report

Prepared for
Todd Pacific Shipyards

Prepared by
Floyd|Snider

FLOYD | SNIDER
strategy • science • engineering

Final
July 27, 2007

TODD PACIFIC SHIPYARDS

Todd Shipyards
Sediment Operable Unit

Remedial Action Completion Report

H1OU6
6.7
7/27/07

Prepared for
Todd Pacific Shipyards

Prepared by
Floyd|Snider

FLOYD | SNIDER
strategy • science • engineering

Final
July 27, 2007

TODD PACIFIC SHIPYARDS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 SIXTH AVENUE
SEATTLE, WA 98101

TARGET SHEET

The following document was not imaged.
This is due to the Original being:

	Oversized
XX	CD Rom
	Computer Disk
	Video Tape
	Other:

**A copy of the document may be requested from the Superfund Records Center.

Document Information

Document ID #:	1273422
File #:	**7.6**
Site Name:	Harbor Island

Remedial Action Completion Report
Todd Shipyards Sediments Operable Unit

REMEDIAL ACTION REPORT
RECORD OF PREPARATION, REVIEW, AND APPROVAL

HARBOR ISLAND SUPERFUND SITE
TODD SHIPYARD SEDIMENT OPERABLE UNIT
EXCAVATION AND CONTAINMENT OF CONTAMINATED SEDIMENTS

EPA CERCLIS ID NUMBER

WAD980722839

This report has been prepared in accordance with EPA OSWER Directive 9320.2-09A and will be used, along with the Remedial Action Report, as a basis for development of the site Final Close Out Report

RA Report Prepared By:	Signature Kathryn H. Snider Name/Title Kathryn H. Snider, Principal Date Floyd|Snider, Inc. 9/20/2007
Approved By:	Signature Lynda Priddy Sheila M Eckman Name/Title Lynda Priddy Remedial Project Manager Sheila M Eckman UMT Manager Date 9/25/07 9/27/07

Remedial Action Completion Report

Todd Shipyards
Sediment Operable Unit

Prepared for
Todd Pacific Shipyards Corporation

Prepared by
FLOYD | SNIDER

July 27, 2007

FINAL

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 Introduction

1.1 GENERAL

This document presents the Final Remedial Action Completion Report (RACR) for remedial action construction activities conducted during the 2004-2005, 2005-2006, and 2006-2007 construction seasons at the Todd Shipyards Sediment Operable Unit (TSSOU or Site) of the Harbor Island Superfund Site, Seattle, Washington (Figure 1.1). This document describes the results of U.S. Environmental Protection Agency (USEPA) Construction Inspections; summarizes construction activities, design changes, and major compliance monitoring results; and demonstrates how remedial action construction activities have achieved performance standards.

The RACR is a formal USEPA deliverable that meets the requirements of the Remedial Action and Long-term Monitoring Statement of Work (SOW) for the TSSOU. The activities described in this document are consistent with project requirements addressed in the Site Record of Decision (ROD; USEPA 1996), two Explanations of Significant Differences (ESDs) written by USEPA to augment the ROD (USEPA 1999; 2003a), the Administrative Order on Consent for Remedial Design (AOC; USEPA 2000), and the Consent Decree (CD; USEPA 2003b) and associated SOW for Remedial Action and Long-term Monitoring (USEPA 2003c).

1.2 SCOPE

As required by the Remedial Action and Long-term Monitoring SOW (USEPA 2003c) this Remedial Action Completion Report addresses the following elements:

- **Section 2.0 Site Background:** Briefly describes the Site background and setting, summarizes the major findings and results of Site sediment investigations, describes the regulatory history of the Site and identifies the remedial action objective, summarizes the remedial design, and provides a summary of source control actions undertaken at the Site.
- **Section 3.0 Remedial Action Summary:** Provides a summary of remedial action construction activities, construction quality assurance efforts, and design changes made during construction.
- **Section 4.0 Construction Activities:** Provides a detailed description and timeline of construction activities completed in each Sediment Management Area (SMA) and summarizes pertinent quality assurance (QA) information documenting successful completion of remedial actions.
- **Section 5.0 Final Inspections, Achievement of Performance Standards, and Certification:** Provides a summary of the interim and final construction inspections and conclusions about the adequacy of the cleanup action throughout the site.
- **Section 6.0 Operation, Maintenance, and Monitoring Activities:** Provides a summary of the monitoring and maintenance activities to be performed to verify the continued long-term effectiveness of the remedy.

- **Section 7.0 Summary of Project Costs:** Provides a summary of the cleanup construction costs.
- **Section 8.0 Observations and Lessons Learned:** Provides Site-specific observations and lessons learned from the project and highlights successes and problems encountered and how they were resolved.
- **Section 9.0 Operable Unit Contact Information:** Provides contact information on the personnel involved in the oversight, design, and construction of the TSSOU remedy.

2.0 Site Background

2.1 TODD PACIFIC SHIPYARDS BACKGROUND AND SETTING

Todd Pacific Shipyards (Todd) is a 30-acre facility located within the Harbor Island Superfund Site. Harbor Island is an industrial area situated at the mouth of the Duwamish Waterway in Seattle, Washington. The industrial island comprises approximately 400 acres plus the adjacent marine sediments in Elliott Bay. The Todd facility is located on the northwest corner of Harbor Island.

The Todd facility, in operation since 1916, is the largest and most productive private ship repair and construction facility in the Pacific Northwest. The Todd marine facilities includes three dry docks and associated piers located on the north end of Harbor Island, two shipways located on the southwest portion of the facility accessed via the West Waterway of the Duwamish River, and nine additional berths located adjacent to Piers 1 through 6 (Figure 2.1). Washington State (managed through the Department of Natural Resources [DNR]) owns all of the TSSOU waterward of the Inner Harbor Line.

Todd provides full service shipyard capabilities to various marine-based industries. Todd's work includes new construction, repair, maintenance, and refurbishing of ships operated by the U.S. Military, fishing fleets, cargo shippers, Washington State ferries, and cruise lines. Todd's dry dock capacity is critical for repair of ships over 200 feet in length; alternative non-military dry docks of similar capacity can only be found in Portland and Canada. Operational facilities include shops for sandblasting, painting, pipe treatment and fabrication, rigging, carpentry, welding, machining, plate bending, and electrical and copper work.

Todd holds key multi-year contracts for ship repair and maintenance with the U.S. Navy. Contracts for U.S. Navy vessel repair and maintenance are critical to national security during this time of war. Todd provides living-wage employment for 800 to 1200 employees annually, primarily union labor.

2.2 TSSOU BACKGROUND

The following section provides a summary of the sediment investigations performed in the TSSOU, the regulatory history with USEPA, and the ROD and Remedial Action SOW requirements for cleanup of the TSSOU.

2.2.1 Sediment Quality

Sediment quality data were collected by Todd and others during Harbor Island and West Waterway remedial investigations and Phase 1 and Phase 2 remedial design sampling and analysis activities in the TSSOU. Details of these activities are provided in the following reports:

- EVS Consultants. 1996. Supplementary Remedial Investigation, Harbor Island Sediment Operable Unit, Volumes I and II. May. (SRI).

- Landau Associates, Inc. 1999. Final Report, Remedial Design, Sampling and Analysis Results, Todd Shipyards Portion of the SSOU, Harbor Island, Seattle, Washington. Prepared for U.S. Environmental Protection Agency. January 11. (Phase 1A).
- EVS Solutions. 1999. Tributyltin in Marine Sediments and the Bioaccumulation of Tributyltin: Combined Data Report. Prepared for Port of Seattle, Lockheed Martin Corporation, and Todd Pacific Shipyards for submittal to U.S. Environmental Protection Agency, Region 10. May (TBT Study).
- Roy F. Weston, Inc. 1999. Final Remedial Design (Phase 1B) Data Report, Todd Shipyards Operable Unit, Seattle, Washington. Prepared by Roy F. Weston, Inc. for U.S. Environmental Protection Agency. September 28.
- Landau Associates, Inc. 2000. Technical Memorandum to Lynda Priddy of USEPA from Pete Rude and Bill Enkeboll Re: Phase 1B Remedial Design Sediment Characterization Results Todd Shipyards Sediment Operable Unit (TSSOU). November 1.
- Landau Associates. 2001. Technical Memorandum to Lynda Priddy of USEPA from Pete Rude and Bill Enkeboll Re: Sediment Chemical, Conventional, and Biological Testing Results Phase 2 Remedial Design Sampling and Analysis, Todd Shipyards Sediment Operable Unit Seattle, Washington. August 10.
- Landau Associates. 2001. Technical Memorandum to Lynda Priddy of USEPA from Pete Rude and Bill Enkeboll Re: Abrasive Grit Blast Evaluation, Todd Shipyards Sediment Operable Unit, Seattle, Washington. December 12.
- Landau Associates. 2001. Technical Memorandum to Lynda Priddy of USEPA from Pete Rude, Bill Enkeboll, and Shannon Dunn Re: Additional Sediment Testing Results, Phase 2 Remedial Design Sampling and Analysis, Todd Shipyards Sediment Operable Unit. December 28.

A technical memorandum dated February 28, 2002 (FSM 2002), and subsequently revised and resubmitted on July 10, 2002, summarizes in tables chemical, biological, and abrasive grit blast (AGB) sediment quality testing data for the TSSOU and compares the data to sediment management standards (SMS) and AGB predominance criteria. Tables 2.1 and 2.2 and Figure 2.2 in this document present a summary of these TSSOU sediment chemical, biological, and abrasive grit blast results prior to construction of the remedial action. Tables 2.1 and 2.2 present sediment results by Sediment Management Units (SMUs) located within nine SMAs, as illustrated on Figure 2.2. To facilitate the remedial design decision-making process, the TSSOU was subdivided into nine SMAs based on land-based features, physical obstructions, extent of open water, and the TSSOU boundary. These nine SMAs are more clearly shown on Figure 2.1.

The chemicals of concern (COCs) in the TSSOU sediments include arsenic, copper, lead, mercury, zinc, tributyltin (TBT), polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs).

2.2.2 Regulatory History

The ROD governing the Shipyard Sediment Operable Unit for Harbor Island was issued in November 1996. An AOC and associated SOW for Remedial Design Sampling was signed in June 1997. Phase 1A characterization activities were completed as defined in the 1997 SOW. The USEPA conducted additional characterization (Phase 1B) in January 1999. Based on the characterization results, USEPA prepared an ESD in December 1999 (USEPA 1999). The ESD designated the TSSOU as a distinct cleanup unit and expanded the TSSOU boundaries. In April 2000, an AOC and associated SOW was finalized for remedial design. USEPA issued another ESD in March 2003 (USEPA 2003a) that:

- Further defined the selected remedy for the under-pier areas
- Established confirmational numbers characteristic of contamination present in the West Waterway for the purpose of adjusting the TSSOU boundary
- Adjusted the TSSOU boundary
- Summarized the long-term operational, maintenance, and monitoring parameters for the TSSOU
- Defined "predominantly abrasive grit blast"
- Identified the disposal approach for contaminated sediments

A CD and associated SOW for the remedial action and long-term monitoring for the TSSOU was finalized in May 2003. Remedial action construction commenced in August 2003 related to source control, utility relocation, and north trestle construction. Cleanup activities were completed during the 2004-2005, 2005-2006, and 2006-2007 in-water construction seasons, as described in this report.

2.2.3 Record of Decision and Remedial Action Statement of Work Requirements

The remedial action cleanup objective for the TSSOU, as stated in the ROD, is to reduce concentrations of hazardous substances to levels that will have no adverse effect on marine organisms (USEPA 1996). For a complete description of the remedy for the TSSOU, refer to the ROD and applicable ESDs (USEPA 1996; 1999; 2003a). To meet the stated ROD cleanup objective and the requirements of the Remedial Action SOW, Todd agreed to conduct the following remedial activities (USEPA 2003c):

- All contaminated sediments and shipyard waste in the open-water areas of the TSSOU will be dredged to depths where contaminant concentrations are less than chemical and/or biological sediment quality standards (SQS) as defined by the SMS (Chapter 173-204 WAC).
- Dredged sediments will be disposed of at an appropriate upland disposal facility.
- Sediment samples will be collected from the post-dredge surface and compared to SQS to verify that performance standards have been achieved. Sediment samples will also be collected from berth deepening areas for characterization of sediment for Puget Sound Dredge Disposal Analysis (PSDDA) disposal.

- Piers 2 and 4S will be demolished and underlying sediments will be dredged to depths where contaminant concentrations are less than SQS, following which Pier 4S will be reconstructed.
- Side-launch shipways on the northeast shoreline will be demolished to facilitate dredging of contaminated sediments. A new ship launching facility will be constructed in this area following dredging to replace the side-launch shipways.
- A sand cap will be placed under Piers 1, 1A, 2 Platform (2P), 3, 6, 6P, and the Building Berth to an average thickness of 1 foot in areas requiring remediation. The sand cap will extend beyond the pier footprints to include the "no dredge zone" immediately adjacent to the piers. Contaminated sediments underneath Piers 1, 1A, 2P, 3, 6, 6P, and the Building Berth will be fully remediated, after demolition, when the existing structures reach the end of their serviceable life.
- A sand cap will be placed under Piers 4N and 5 to an average thickness of 3 feet in areas requiring remediation. The sand cap will extend beyond the pier footprints to include the "no dredge zone" immediately adjacent to the piers. Contaminated sediments underneath Piers 4N and 5 will be fully remediated, after demolition, when the existing structures reach the end of their serviceable life.
- Sources of contaminants to the sediments will be controlled before remedial action implementation is complete. Source control actions include upgraded management of sandblast grit, as well as collection and treatment of contaminated industrial stormwater to prevent sediment recontamination.
- The existing timber Dry Dock 2 will be replaced with a metal surfaced dry dock as an element of site source control, allowing better future collection of spent sandblast grit. The metal surfaced dry dock will be relocated to the east side of Pier 6. Dredging to increase berth depths will be conducted along the east side of Pier 6 to accommodate the new dry dock, and a new anchoring system and access ramp will be constructed.
- During in-water activities, water quality monitoring will be performed and compared to Washington State acute marine water quality criteria or background concentrations and, if necessary, corrective actions will be taken to mitigate impacts to water quality during construction.
- Dredging, capping, and disposal methods will be utilized to minimize adverse impacts to habitat and minimize the release and resuspension of contaminated sediments to the environment.
- Remedial activities will be conducted following best management practices (BMPs) to avoid and minimize adverse impacts to the aquatic environment, which includes avoiding fish-critical activity periods for in-water work and implementation of conservation measures that protect species listed on the Endangered Species Act (ESA).
- Long-term maintenance and monitoring of the under-pier sand cap will be conducted at the TSSOU to verify the continued effectiveness of the remedy. As part of 5-year reviews, USEPA may also require monitoring of the open-water areas.

The remedy for the TSSOU meets the ROD cleanup objective and Applicable or Relevant and Appropriate Requirements (ARARs), while supporting continued operations at the shipyard.

2.2.4 Cleanup Standards

As stated above in Section 2.2.3, chemical and biological cleanup standards that meet the ROD cleanup objective are contained in the SMS (Chapter 173-204 WAC). The SMS define two levels of chemical and biological standards for sediment, as described below. If both chemical and biological data are collected, the biological data determine compliance with the SMS.

- **Sediment Quality Standard (SQS)**—the chemical standard that corresponds to a sediment quality that has no adverse effect on benthic marine organisms.
- **Cleanup Screening Level (CSL)**—the chemical concentration above which minor adverse effects are predicted to always occur in benthic marine organisms.

The SQS is the compliance criteria for the TSSOU, except for tributyltin (TBT), where no SQS criterion exists and the compliance criterion is based on the confirmational number stated in the 2003 ESD. COCs for the TSSOU, and their corresponding compliance criteria, are shown below.

Chemical Parameter	Units	Criteria[1]
Arsenic	mg/kg	57
Copper	mg/kg	390
Lead	mg/kg	450
Mercury	mg/kg	0.41
Zinc	mg/kg	410
polychlorinated biphenyls (PCBs)	mg/kg-OC	12
PCBs	µg/kg	130[3]
Low-molecular weight polycyclic aromatic hydrocarbons (LPAHs)	mg/kg-OC	370
LPAHs	µg/kg	5,200[3]
High-molecular weight polycyclic aromatic hydrocarbons (HPAHs)	mg/kg-OC	960
HPAHs	µg/kg	12,000[3]
tributyltin (TBT)	mg/kg-OC	76[2]
TBT	µg/kg	1,335[2,3]

Notes:

1 Compliance criteria based on SQS chemical criteria per Washington State Sediment Management Standards (SMS; Chapter 173-204 WAC), except otherwise noted.

2 Compliance criteria based on confirmational number stated in the 2003 ESD.

3 Compliance criteria based on the dry weight concentration will be used when the total organic carbon (TOC) value is less than 1%.

2.3 REMEDIAL DESIGN SUMMARY

The following sections provide an overview of the remedial design for the TSSOU. The remedial action specified for each area of the Site is illustrated in Figure 2.3, Remedial Design Summary.

2.3.1 Cleanup in Open-water Areas

Dredging was required in all open-water areas of the TSSOU, to depths where contaminant concentrations were anticipated to be less than SQS criteria and the TBT "confirmational number" listed in the 2003 ESD (USEPA 2003a). All dredged spoils were specified to be disposed off-site, at an upland Subtitle D landfill. The northeast portion of SMA 1 was not required to be dredged because both surface and subsurface sediments in this area were known to be in compliance with project cleanup criteria.

The design called for demolition of Pier 2 because it was out of service as a result of poor structural condition and because demolition allowed dredging of contaminated sediments beneath the pier. Demolition also included removal of approximately 800 creosote-treated timber piles from the aquatic environment. Because Pier 2 was not critical for shipyard operations, replacement of this structure was not necessary. Demolition of Pier 2 therefore was anticipated to have a beneficial habitat effect by increasing light passage to subtidal aquatic habitat.

The design also required demolition of the Side-launch Shipways and Pier 4S, dredging of areas within the footprint of these structures, and reconstruction of these structures. The design of these actions is further described below.

The design specified placement of habitat mix over all riprap armoring above elevation –10 feet Mean Lower Low Water (MLLW). The approximate extent of the habitat mix placement is shown on Figure 2.3. The design called for habitat mix to be placed at a rate of 25 tons per 1,000 square feet. The goal of placing this material on the armored slopes is to plug the interstitial spaces within the riprap to eliminate hiding places for organisms that prey on juvenile salmonids and improve substrate conditions for fish and other aquatic species.

2.3.2 Capping Below Piers

The areas beneath piers that were not demolished were required to be covered with a sand cap. The cap material was intended to provide environmental benefits by reducing exposure to contaminated sediment and source control by reducing the movement of underlying sediments. In addition, the cap material was intended to provide improved substrate conditions for fish and other habitat enhancement benefits. No remedial action was called for in under-pier areas above elevation 0 feet MLLW, where riprap contains minimal or no visual sediment.

Where existing timber piers were determined to be critical for continued shipyard operations and in fair to good condition with remaining serviceable life (e.g., the Building Berth, Piers 1A, 1, 2P, 3, 6P, and 6), a best effort procedure was specified to place an overall average of 1 foot of sand to cover contaminated sediment areas. Similarly, a best effort procedure was specified to place an average of 3 feet of sand beneath existing concrete piers (Piers 4N and 5).

The design also called for the containment of the significant consolidated debris mound under Pier 6P by covering the pile with fiber reinforced shotcrete.

2.3.3 Pier 4S Demolition, Cleanup, and Reconstruction

The design mandated demolition of Pier 4S because of the deteriorated condition of the pier and the significant sediment contamination that was known to exist beneath the pier. Pier 4S was the largest over-water structure at the Todd facility, with a footprint of approximately 76,000 square feet. Demolition of the Pier 4S structure allows removal of approximately 1,735 creosote treated timber piles from the aquatic environment and dredging of underlying sediments, including removal of significant consolidated debris mounds located under this pier.

Following completion of demolition and dredging, the design required that intertidal areas beneath this pier be backfilled to construct a habitat bench with preferential elevations of +2 to –2 feet MLLW.

Because Pier 4S was critical to shipyard operations, the design anticipated it would be re-built following completion of cleanup actions. Design of the new pier envisioned a modified configuration that met shipyard operational requirements (by providing a continuous pier at the location of the existing berth) but reduced over-water coverage, thereby allowing light penetration to intertidal and subtidal areas as a habitat enhancement benefit.

In 2005 Todd made a financial decision not to reconstruct Pier 4S. In lieu of rebuilding this structure Todd chose to construct a simple trestle extending from the Northwest corner of the upland to Pier 4N (to provide continued access to this pier).

2.3.4 Side-launch Shipways Demolition, Cleanup, and Reconstruction

The design also called for demolition of the side-launch shipway, located on the northeast shoreline, in order to achieve more complete cleanup of this area and to remove approximately 235 creosote-treated timber piles from the aquatic environment. Following demolition, the area previously covered by the side-launch shipway was specified to be dredged to remove sediments exceeding SQS criteria and co-mingled debris. Following dredging, the northeast shoreline was specified to be backfilled with clean fill to balance lost intertidal acreage above elevation –10 feet MLLW. The design required placement of habitat mix on the surface of reconstructed slope armor material above –10 feet MLLW between Pier 6 and the eastern property boundary to soften the slope substrate, thereby improving fish habitat.

Because the ship-launch facility is critical to shipyard operations, the design anticipated it would be re-built following completion of cleanup actions. Todd made the decision in 2006 to relocate the planned ship-launch facility from the northeast shoreline to the western shoreline, within the former footprint of Pier 4S.

2.3.5 Habitat Improvements

In addition to cleanup actions, the project remedial design included provisions for habitat improvements, as briefly described in the sections above. These actions were specified to be constructed concurrently with cleanup actions to significantly improve existing TSSOU intertidal and subtidal habitat for juvenile salmonids. The habitat improvements include:

- Cleanup of contaminated sediments and shipyard waste
- Softening of exposed armored slopes
- Increased light passage to intertidal and subtidal regions along the West Waterway
- Intertidal bathymetry and substrate improvements at the northeast shoreline and Pier 4S areas
- Permanent removal of approximately 2,800 creosote-treated timber piles

These habitat improvement actions are consistent with both the remedial action design and continued operation of the shipyard.

One of the goals of the design of the reconstructed shoreline areas was to minimize loss of intertidal acreage. A habitat mitigation evaluation was conducted to determine the effects of the remedial design on habitat within the TSSOU, as discussed in the Final Design Report. The results of this evaluation indicated:

- A net increase of 0.04 acres of intertidal habitat (+10 to -10 feet MLLW)
- A net decrease (habitat benefit) of over-water coverage of 46,549 square feet
- A net increase (habitat benefit) of habitat friendly intertidal substrates

Based on the final design, the total intertidal area of the project did not change substantially.

Aquatic over-water coverage impacts were reevaluated once Todd made the decision not to reconstruct Pier 4S, and instead chose to construct a trestle connecting to Pier 4N and a ship-launch facility within the former footprint of Pier 4S. Based on this evaluation there was an additional net decrease in over-water coverage of 23,235 square feet (Floyd|Snider 2006). The resulting total net decrease in over-water coverage for the constructed remedial action compared to pre-project conditions is 69,784 square feet.

2.4 COMPLETED SOURCE CONTROL ACTIONS

Prior to remedial action construction, Todd implemented two primary source control projects to eliminate shipyard sources of sediment contamination. Stormwater management infrastructure was reconstructed throughout the primary industrial areas of the yard and operational changes were made regarding the handling of AGB.

2.4.1 Shipyard Stormwater Discharges

Six stormwater drainage basins and associated outfalls at Todd were identified by the Washington State Department of Ecology (Ecology; via the National Pollutant Discharge Elimination System [NPDES]/analysis of all known, available and reasonable methods of prevention, control and treatment (AKART) analyses process) to be of concern as a source of contaminants to water and sediment quality. Significant stormwater system modifications;

involving collection, pre-treatment, and discharge to an off-site Publicly Owned Treatment Works (POTW), were implemented in 2003. This project successfully eliminated stormwater discharges as a source of sediment recontamination within the TSSOU. For this work, Todd received the Mayor's "BEST Award" and the US Coast Guard's prestigious "Admiral William H. Benkert Award" acknowledging excellence in stormwater pollution prevention.

2.4.2 Shipyard Operations

Based on in-place controls via BMPs and other related shipyard practices, the risk of sediment recontamination from shipyard operations is low. In-place protocols specify safe hazardous substances work, and minimize the risk of environmental spills during operations such as oily sludge removal and refueling. Painting is performed in well-controlled environments, and the leaching of TBT from paints as an on-going TBT source is minimized due to a phase-out of TBT-containing paint usage.

To address the risk of spent sandblast grit releases to sediments via dry dock operations, Todd implemented new dry dock spent grit management protocols in 2003 prior to the initiation of remedial actions in the TSSOU. These included eliminating use of Dry Dock 2 (this dry dock has since been demolished and disposed of), improving the dry dock wash water collection and treatment system, and using spent grit containerization on the dry docks to eliminate transport, stockpiling, and double handling of loose grit within the shipyard.

3.0 Remedial Action Summary

This section provides a chronology of events, summary of construction quality assurance efforts (Appendix A), and a summary of construction activities and design changes completed during remedial action construction (Appendix B).

3.1 CHRONOLOGY OF EVENTS

The chronology of major events for the TSSOU is summarized in the following table.

Harbor Island Shipyard Sediment Operable Unit ROD	November 1996
AOC and SOW for Remedial Design Sampling	June 1997
ESD that designated TSSOU as a distinct cleanup unit and expanded TSSOU boundaries	December 1999
AOC and SOW for TSSOU Remedial Design	April 2000
ESD that defined under-pier remedy, established confirmational numbers for adjusting the TSSOU boundary, adjusted TSSOU boundary, long-term OMMP, defined AGB, and identified disposal approach	March 2003
CD and SOW for Remedial Action and Long-term Monitoring	May 2003
Remedial Action Construction: source control actions, utility relocation, and north trestle construction.	August 2003–December 2003
2004-2005 Remedial Action Construction: demolition, dredging and capping	July 2004–February 2005
Interim Construction Inspection by USEPA	March 2005
2005-2006 Remedial Action Construction: demolition, dredging and capping	July 2005–January 2006
Interim Construction Inspection by USEPA	February 2006
2006-2007 Remedial Action Construction: shipyard infrastructure replacement	July 2006 - February 2007
Completion of all Remedial Action Construction	February 2007
Final Construction Inspection by USEPA	July 2007
Long-term OMM	Baseline to be completed in fall 2007, monitoring to begin in fall 2008

3.2 REMEDIAL ACTION CONSTRUCTION

3.2.1 Construction Team

The construction team for this project consisted of General Construction Company (GCC) and their subcontractors (primary subcontractors were R. W. Rhine and Island Tug & Barge), responsible for all on-site construction work, and Rabanco Regional Disposal Company (RDC) and their subcontractors (primary subcontractors were Wilder Construction Company, Clearcreek Contractors, Inc., and BNFS Railroad), responsible for transloading, transportation and landfill disposal of sediment, shipyard waste, and demolition debris. Both GCC and RDC were contracted directly to Todd.

3.2.2 Summary of Construction Efforts

Remedial action construction work was initiated in July 2004. Remedial construction efforts during the first season were focused along the north end of the Site, and included:

- Completed demolition and disposal of the side-launch shipways, located along the Northeast Shoreline in SMA 1, and Pier 2, located in SMA 8.
- Completed dredging and disposal of contaminated sediment and shipyard debris in SMAs 1, 2, 3, 4, and 5, located on the north side of the Todd property.
- Completed placement of under-pier cap material at Pier 4N, Pier 5, Pier 6, and Pier 6P.
- Completed placement of in-water fill, including reconstruction of the Northeast Shoreline slope in SMAs 1 and 2; filling of subtidal depressions in SMAs 3, 5, and 7; and placement of boundary sand in SMAs1 and 5.
- Initiated, but did not complete, dredging and disposal of contaminated sediment in SMAs 7, 8, and 9.

Second season (2005-2006) remedial construction efforts were focused on the west end of the Site and included:

- Completed demolition and disposal of Pier 4S located in SMA 6 and removal of the decking from the western portion of the building berth located in SMA 8.
- Completed dredging and disposal of contaminated sediment and shipyard debris in SMAs 6, 7, 8, and 9, located on the west side of the Todd property.
- Completed placement of under-pier cap material at Piers 1A, 1, 2P, 3, and the building berth area.
- Completed placement of in-water fill including placement of boundary sand in SMA 7 and 9 and placement of fill in the subtidal depression in SMA 7.
- Completed construction of the SMA 6 buttress fill, habitat bench, and slope armoring.

The final remedial construction effort occurred during the 2006-2007 in-water construction season and included completion of the replacement of structures that had been demolished to facilitate sediment cleanup. This work included the installation of fender piling at Piers 5 and 6 and the construction of a replacement level-launch facility at the area formerly occupied by Pier 4S.

Construction drawings and specifications for the project are included in Appendix B, along with Construction Change Directives that describe changes to construction plans and specifications made during construction.

3.3 QUALITY ASSURANCE INSPECTIONS, MONITORING, AND REPORTING

3.3.1 Construction Quality Assurance Team

The Construction Quality Assurance Team for this project was composed of Floyd|Snider and their subcontractors. Floyd|Snider provided full time on-site project management services consisting of a resident engineer, field engineers, and QA inspectors.

Floyd|Snider was assisted by several specialty consultants, analytical laboratories, and material testing laboratories, including:

- MCS Environmental, Inc. (MCS)—Water quality monitoring and post-dredge sediment quality sampling
- Analytical Resources, Inc. (ARI)—Chemical analytical testing to support water quality and sediment quality monitoring
- EVS Environmental Consultants—Biological testing to support sediment quality monitoring
- Rosa Environmental & Geotechnical Laboratory, Inc. (Rosa)—Physical parameter testing of imported fill and cap materials
- KPFF Consulting Engineers, Inc. (KPFF) and PanGEO Inc.—Structural and geotechnical engineering
- David Evans and Associates (DEA)—Survey control
- Taylor Associates—Fish monitoring
- Research Support Services—Dive surveys of under-pier capping in SMA 8

3.3.2 Summary of Construction Quality Assurance Efforts and Reporting

3.3.2.1 Daily Construction Quality Assurance Inspections

During the first two seasons of construction, Floyd|Snider performed daily QA inspections of construction activities to ensure the Contractor conducted construction operations in compliance with the approved quality control plan and satisfied requirements of the project BMPs as presented in the RAWP (FSM 2004). Daily inspections involved visual observation of construction activities, coordination with the Contractor, and photograph documentation.

On a daily basis Floyd|Snider representatives submitted a Construction Quality Assurance (CQA) Daily Summary Report to USEPA documenting construction activities and results of quality control (QC) and QA inspections and monitoring. The CQA Daily Summary Report contained the following information:

- Checklist description of work performed.
- Summary of daily construction activities and description of water and sediment quality monitoring efforts (when applicable).
- Checklist verification that project BMPs were satisfied.
- Description of potential concerns, corrective actions, and changes in construction methods (as applicable).
- Photographs depicting a summary of the daily construction activities.

In addition to the QA information listed above, the CQA Daily Summary Reports also provided observational and analytical results of water quality monitoring efforts on days when water quality monitoring was performed at the Site. A detailed description of the water quality monitoring effort is presented in Section 3.3.2.2.

During the final season of construction, Todd Shipyard personnel provided construction inspections to ensure that BMPs were satisfied and construction met design requirements during construction of fender piling and the replacement level-launch structure.

Results of the remedial action construction quality assurance inspections indicate that remedial construction was completed in compliance with the project plans and specifications and according to RAWP requirements. Section 5.0 discusses and documents how the remedial action objective, stated in the ROD and Remedial Action SOW, was achieved and provides conclusions about the adequacy of the completed cleanup action. Copies of the remedial action construction CQA Daily Summary Reports are provided in Appendix A.

3.3.2.2 Water Quality Monitoring

Floyd|Snider and MCS provided water quality monitoring services according to requirements provided in the RAWP, Remedial Action Construction Quality Assurance Plan (CQAP), and Remedial Action Sampling and Analysis Plan (RASAP; FSM 2004). Visual turbidity monitoring was performed during demolition of over-water structures (side-launch shipways, Pier 2, Pier 4S, and building berth decking) and intensive and routine water quality monitoring was performed during dredging and barge dewatering and filling/capping operations.

Visual Turbidity Monitoring

Floyd|Snider performed visual turbidity monitoring during demolition of the side-launch shipway (SMA 2), Pier 2 (SMA 8), Pier 4S (SMA 6), and building berth decking (SMA 8). Visual turbidity monitoring was conducted to ensure that turbidity generated as a result of construction activities remained within acceptable limits as defined in the RAWP and RASAP. Results of visual turbidity monitoring indicated that turbidity, if any, generated during demolition of over-water structures in the remedial action construction remained within the acceptable limits.

Results of visual turbidity monitoring are included in the CQA Daily Summary Reports (Appendix A) for periods when over-water structure demolition activities were performed. A visual turbidity monitoring form is attached to the CQA Daily Summary Reports for activities related to the demolition of the side-launch shipway structures and a description of monitoring results is provided within the construction summary section of the daily reports for activities related to demolition of Pier 2, Pier 4S, and the building berth decking.

Intensive and Routine Water Quality Monitoring

MCS performed intensive and routine water quality monitoring during dredging/barge dewatering and cap/fill placement operations as specified in the RASAP. During the 2004-2005 construction season, 6 days (events) of intensive water quality monitoring were performed between August 18 and 25, 2004 and 3 days (events) of routine water quality monitoring were performed between September 1 and 7, 2004 for construction activities related to dredging and barge dewatering. An additional day (event) of routine water quality monitoring was performed on October 1, 2004 for construction activities related to placement of in-water fill.

During the 2005-2006 construction season, 6 days (events) of intensive water quality monitoring were performed between August 16 and 23, 2005 and 3 days (events) of routine water quality monitoring were performed between August 26 and September 6, 2005 for construction activities related to dredging and barge dewatering and Pier 4S demolition.

Each intensive and routine water quality monitoring event related to dredging/barge dewatering and cap/fill material placement involved collection of in situ data and representative water samples (for laboratory analysis) at the following four monitoring locations surrounding the construction activity:

- Two compliance stations located 300 feet down current of construction activity.
- One midpoint station located 150 feet down current of construction activity.
- One reference (ambient) station located up current from and outside the influence of the construction activity.

In situ data, including turbidity, dissolved oxygen, temperature, and salinity, were measured at three depths (near-surface, mid-water, and near-bottom) at each monitoring location and results at the compliance and midpoint stations were compared to the Washington State marine water quality standards and reference (ambient) conditions to ensure water quality parameters did not exceed acceptable limits. Additionally, water samples were collected at each monitoring location (at the depth of highest turbidity) and analyzed for total suspended solids (TSS) and COCs. It is important to note that salinity and TSS data were collected and analyzed for informational purposes only.

Results of intensive and routine water quality monitoring analyses indicate that water quality remained within marine quality standards throughout the monitored events related to dredging/barge dewatering and in-water fill placement construction activities. Per USEPA approval, intensive and routine water quality monitoring efforts for the 2004-2005 construction season were discontinued on October 1, 2004 and on September 7, 2005 for the 2005-2006 construction season. Visual water quality monitoring was conducted throughout the remainder of the construction season; however, no additional intensive or routine monitoring event was performed.

Results of routine and intensive water quality monitoring events are summarized at the end of the relevant CQA Daily Summary Reports (Appendix A) for periods when monitoring was performed. Results of all in situ and laboratory analyses (including comparison to compliance criteria) are included in the summary reports.

3.3.2.3 Post-dredge Sediment Sampling and Analysis

The quality of the post-dredge sediment surface was routinely and thoroughly evaluated through the collection and analysis of progress sediment verification samples. Progress samples were collected as cores using the procedures prescribed in the RASAP. Likewise, the frequency and location of sampling was consistent with those specified in the RASAP.

Laboratory analysis of the sediment samples was conducted in strict compliance with the protocols described in the RASAP and Quality Assurance Project Plan (QAPP; FSM 2004). Analytical results were compared to project compliance criteria (SMS and TBT confirmational criteria) and the outcomes of these comparisons were used to direct re-dredging efforts, as necessary.

Results of the final post-dredge sediment progress sampling and analysis are summarized in Table 3.1. Sample locations are shown in Figure 3.1. Field logs, analytical laboratory reports, and data validation documentation is provided in Appendix A for the final progress sediment samples. A discussion of these analytical results from each SMA is provided in Section 4.0.

3.3.2.4 Shipyard Waste and Sediment Disposal

Floyd|Snider conducted periodic inspections of shipyard waste and sediment off-loading and transportation staging activities at Terminal 25 (T-25) to confirm that BMPs for these activities were routinely implemented. BMP implementation at T-25 is further discussed in Section 4.9. Upon receipt and disposal of the waste material, RDC prepared a Disposal Certificate that identified the generator site and owner, the date the barge of shipyard waste and sediment was received, the weight of material off-loaded from the barge, the sequential number of the barge, and a certification that RDC took title and ownership of the material and disposed of the material in their Roosevelt Regional Landfill facility. Copies of the Certificates of Disposal for the 202 barge loads of shipyard waste/sediment disposed of during the remedial action construction are provided in Appendix A.

3.3.2.5 Tribal Treaty Fishing Coordination

As part of the RAWP, a Tribal Fishing Coordination Plan was developed to describe the coordination with Treaty Fisheries to occur during all construction activities. Floyd|Snider communicated with Mike Mahovlich of the Muckleshoot Tribe and Jay Zischke of the Suquamish Tribe by telephone periodically during the tribal fishing seasons. These communications, along with "in-water communications" between GCC and the fishermen successfully minimized conflicts between in-water construction and tribal fishing activities.

3.3.2.6 Fish Monitoring

Fish monitoring was first performed between February 1 and February 25, 2005 to evaluate potential impacts to juvenile Chinook salmon and bull trout during the time that in-water construction occurred beyond the originally permitted in-water construction window of February 15th. A second fish monitoring event began in February 2007 when it was anticipated that in-water construction would occur beyond the in-water construction window. As the construction work was completed by February 11, 2007, the 2007 fish monitoring event was not continued past February 9th. Fish monitoring during both construction seasons was performed following a tiered approach in accordance with the USEPA-approved Fish Monitoring Plan. The Fish Monitoring Plans and monitoring results for both the 2005 and 2007 events are presented in Appendix C.

During the first two weeks of February 2005, Level 1 Monitoring consisted of weekly beach seine monitoring at the Turning Basin in the Duwamish River (river mile 5), upstream of the TSSOU. The purpose of this monitoring was to provide an indication of the migration timing of juvenile Chinook salmon into the Duwamish River and ultimately into the West Waterway. The Level 1 monitoring criteria of 100 juvenile Chinook/seine (as an average catch of three beach seines in a day) was not exceeded during this monitoring period. During February 15 to 25, 2005, Level 2 beach seine monitoring was performed at two additional locations in the West Waterway 1) near the head of the waterway at the Port of Seattle public access beach just south of Fisher Flour and 2) at the Lockheed beach site just upstream of the TSSOU. Level 2 Monitoring was conducted twice a week in conjunction with the continued monitoring at the Turning Basin. The Level 2 monitoring criteria of three Chinook salmon or bull trout/seine (as an average catch of three beach seines in a day) was not exceeded during the monitoring period.

For the February 2007 monitoring, two Level 1 beach seining events took place at the Turning Basin in the Duwamish River. No threshold exceedances occurred during these Level 1 fish monitoring events. Level 2 monitoring was not completed as all in-water work was completed within the in-water construction fish window.

3.3.2.7 Project Meetings

A Pre-construction Meeting was held at the Site at the beginning of each construction season (e.g., on July 23, 2004 and June 10, 2005) with USEPA, Todd, GCC, RDC, and Floyd|Snider personnel in attendance. Subsequently, these same attendees held Weekly Progress Meetings at the Site every Friday from July 2004 through February 2005 and from June 2005 through November 2005. Following completion of 2004–2005 construction operations, an Interim Construction Inspection Meeting was held at the Site on March 8, 2005. Similarly, an Interim Construction Inspection Meeting was held at the T-25 site on February 23, 2006. Notes from these project meetings were maintained by and distributed to attendees by Floyd|Snider, and are provided in Appendix A. Following completion of 2006–2007 construction operations, a Final Construction Inspection Meeting occurred on July 11, 2007 with USEPA and Floyd|Snider personnel in attendance.

3.4 COMMUNITY RELATIONS ACTIVITIES

Site visits were conducted with Natural Resource Agency Representatives and the Duwamish Cleanup Coalition during the first few months of construction in Summer 2004. Throughout the remedial action construction there was ongoing communications with the Muckleshoot and Suquamish Indian Tribes, as discussed above in Section 3.3.2.5.

3.5 HEALTH AND SAFETY

No health and safety problems were encountered during construction. Safety updates were included in the Weekly Progress Meetings. These meeting notes are included in Appendix A. Air quality monitoring was performed by Prezant, a health and safety consultant, in August 2004, and included the collection of air samples from the barge area during dredging. Prezant indicated that current heath and safety operations were acceptable.

Modified Level D personal protective equipment (PPE) was required for site personnel for general site activities. This equipment included rain gear or coveralls, safety boots, gloves, eye protection, and hard hats.

3.6 SUMMARY OF CHANGES TO DESIGN, CONSTRUCTION METHODS, AND QUALITY ASSURANCE PROCEDURES

Changes made to the remedial action design, construction methods, and quality assurance procedures are described below. Further details on changes to construction plans and specifications are provided in Construction Change Directives that were issued during the construction work (included in Appendix B). These Construction Change Directives include revised construction drawings where applicable.

3.6.1 Dredging and Dewatering

3.6.1.1 Changes to Dredging and Dewatering Construction Methods

GCC worked hand in hand with Floyd|Snider to finalize construction plans and technical specifications for this project. As a result GCC put significant thought and energy into the BMPs specified for dredging and dewatering activities. In order to reliably meet dredging and barge dewatering BMPs, GCC made an early decision to commit the D. B. Seattle and a 24-cubic-yard Cable Arm environmental clamshell bucket to the project. The D.B. Seattle is the largest dredging derrick barge in GCC's extensive equipment fleet and the 24-cubic-yard Cable Arm environmental bucket is the largest environmental clamshell bucket owned by GCC. The large footprint and volume capacity of the Cable Arm bucket and the ability of the large derrick barge to operate this bucket brought significant benefits to the dredging operation. Specifically, the large clamshell bucket minimized loss of sediment and subsequent redistribution; made it more cost effective to cover dredge areas several times—thereby improving the ability to meet cleanup criteria; and provided the ability to selectively remove recent sediment deposits (e.g., contaminated sediments) down to the native sediment contact (refer to the discussion of Dredge Method 2 below).

An additional benefit of employing the large derrick barge and large dredge bucket was the ability to utilize large volume transport barges that were separate from the dewatering barge. Original plans envisioned having two or three dewatering barges that would be iteratively filled, allowed to dewater, and then towed to the transload facility for off-loading. Use of the large bucket made it cost effective to double handle sediment (initially placing it on the sloped barge to dewater and then transferring it to the hopper barge for off-site transport). This in turn allowed the dewatering barge to be customized to serve the sole purpose of dewatering, which allowed the dewatering process to be modified such that return water ponded on the sloped barge, causing fines to settle out, prior to being discharged to the waterway. This significantly improved GCC's ability to minimize turbidity impacts to receiving waters, while maintaining effective dredging production rates.

3.6.1.2 Changes to Dredge Design and Quality Assurance Procedures

One of the characteristics of Cable Arm environmental clamshell buckets is that they weigh less then traditional clamshell buckets per unit volume. This characteristic, combined with the fact that these buckets are designed to make level cuts, resulted in the dredge operator being able to discriminate hard native (typically clean) material underneath the soft overburden (typically contaminated). This provided an opportunity to identify the depth of required dredging based on specific location-by-location information, rather than by meeting design dredge depths called out in the construction drawings (which had been developed chiefly based on the estimated depth to native sediments at a limited number of remedial investigation sample locations).

A change to the technical specifications was implemented to formalize the acceptability of this new dredging method. The revised specifications identified:

- **Dredge Method 1**—Dredging to Post-Dredge Target Elevations. This is a re-statement of the original specified method for dredging.
- **Dredge Method 2**—Dredging to Hard Material in Open-water Areas. Where it is possible for the dredge operator to "feel" using the 24-cubic-yard Cable Arm clamshell bucket hard material underneath the soft overburden, dredge to fully remove the soft overburden, and scrape the top of the hard material to create the final dredge surface. Follow this procedure irrespective of the relationship of the hard material elevation to the design dredge depth.

The Contractor was then directed to conduct dredging per Dredge Method 1 or Dredge Method 2 on a SMA-by-SMA basis. Section 4.0 provides details about dredging implementation in each SMA.

Based on the revised approach for dredging the QA procedure to verify compliance with design objectives relied solely on post-dredge sediment sampling and analysis (to confirm compliance with cleanup criteria). Post-dredge multibeam bathymetric surveys were therefore not performed.

3.6.1.3 Changes to Dredging Limits in Sediment Management Area 9

As dredging proceeded in SMA 9 it was learned that the typically submerged western edge of the building berth was approximately 40 feet further west than indicated on the project construction drawings. This area could therefore not be dredged and was capped with 1 foot of sand consistent with the design for the adjacent building berth areas. The extent of actual dredging and capping is shown on Figure 3.2.

3.6.2 Under-pier Capping

GCC and Floyd|Snider worked cooperatively to develop an acceptable construction approach for placement of sand cap material beneath pier structures at the Site. The selected approach used a "throwing conveyor", mounted on a series of modular floats, to propel sand from the face of the piers to the under-pier areas to be capped. Specific construction procedures and related QC measures were developed to place a calculated volume of sand cap material within a measured area beneath the piers, in a reproducible and verifiable manner that satisfied the following design criteria:

- Place 1 foot (average thickness) of sand beneath pier structures supported by timber piling.
- Place 3 feet (average thickness) of sand beneath pier structures supported by concrete piling.

Per design requirements included in the RAWP, GCC performed a two-phase cap placement test program prior to the start of production under-pier capping. The first phase involved throwing sand onto a flat-deck barge that was set up to mimic under-pier capping areas using wood templates. This phase provided an opportunity for construction personnel to become familiar with the operation of the capping equipment and to verify that calculated material placement volumes would meet required cap thicknesses. The second phase involved placing a predetermined volume of sand cap material within five bays (areas between existing pile bents) along the east side of Pier 6. The following QA/QC procedures were implemented during the under-pier placement phase of the test program to verify results.

- Pre- and post-cap placement lead line soundings were performed in each bay to measure the aerial extent and approximate average thickness of material placed.
- A series of sampling buckets were suspended near the bottom of the water column (prior to material placement) within one bay to measure the thickness of cap material placed within the intended area.
- A post-cap placement diver survey of the test program area at Pier 6E was conducted to provide visual observation and physical measurement data regarding the extent and thickness of the cap.

The cap placement test program was completed between October 11 and 13, 2004. Pre-cap QA/QC procedures were performed and material volumes equivalent to a 1-foot-thick cap were placed within each test bay. After completion of material placement, post-cap QA/QC procedures were performed yielding the following results and subsequent changes to the QA procedures:

- Measurements of cap thickness (for material placed during the initial phase of the test program) satisfied design criteria and calculated material placement volumes were determined to be accurate.

- Post-cap diver survey data provided the most accurate representation of the test program cap area. Visual observations indicated that cap material was evenly distributed about each bay with minimal mounding of material and no evidence of shadowing around existing timber piles. Additionally, physical measurements regarding post-placement cap thickness provided verification that design criteria were satisfied.
- Pre- and post-cap lead line soundings did not provide consistent results, likely because of the difficulty in collecting measurements at the same exact location (for pre- and post-cap conditions). Results were discussed with USEPA and, with their concurrence, future use of lead line soundings was eliminated.
- Recovery of cap material in the sampling buckets also did not provide consistent results. In general, the average recovered thickness of material in the sampling buckets was less than the in situ thickness observed by the diver survey. Per USEPA approval, the future use of sampling buckets was also eliminated.

3.6.3 In-water Filling

3.6.3.1 Northeast Shoreline Cap

The original design for remediation and restoration of the Northeast Shoreline required complete removal of contaminated sediments via mechanical dredging and subsequent placement of fill to create shallow aquatic habitat and provide for shoreline protection.

Following completion of dredging, sampling and analysis determined that project cleanup criteria had not been met at two of the sampling locations in SMA 2. Additional dredging to remove the remaining contaminated sediment was not possible because of slope stability constraints.

Todd and USEPA decided to alter the design of the planned shoreline fill such that the fill would function as a permanent containment cap. At the time that this decision was made, shore protection riprap had already been placed above –5 feet MLLW in SMA 1. It was determined that all other areas of the shoreline fill would be constructed such that a minimum 2–foot-thick isolation layer of gravelly sand material would be placed below the planned 3-foot riprap layer. The 2-foot gravelly sand layer was specified to match the requirements of the isolation layer designed for the adjacent Lockheed Shipyard Sediment Operable Unit (LSSOU), as the LSSOU cap design was approved for containment of similar COCs.

One of the original goals of the Northeast Shoreline fill was to create preferential elevations for aquatic habitat. To meet this goal, most areas of the fill cross section have well in excess of the minimum 2 feet of gravelly sand fill below the riprap armor layer. In some places, this material is greater than 20 feet thick.

Additional sampling and chemical and bioassay analysis to more fully characterize the post-dredge conditions of the slope area was implemented concurrent with implementation of the shoreline fill design revision. It was agreed that the sampling results would be used to delineate the area exceeding cleanup criteria and therefore the area that would be defined as a permanent containment cap. Additionally, the additional characterization data was used to verify that the re-designed shoreline fill section was adequate to provide the required cap functions. Results of the supplemental characterization and cap design verification are presented in Appendix D.

3.6.3.2 Sediment Management Area 6 Habitat Bench

The material originally planned to be placed on the surface of the SMA 6 habitat bench was mandated by the natural resource agencies (National Oceanographic and Atmospheric Administration [NOAA], United States Fish and Wildlife Service [USFWS], and Washington State Department of Fish and Wildlife [WDFW]) to be the "habitat mix" material that they had recently installed at Commencement Bay restoration sites. This material is clean, naturally occurring round or sub-angular river sand and gravel, all of which is smaller than 1-1/2 inches in diameter.

During 2004 the natural resource agencies and USEPA point of view on this issue evolved. At the pre-construction meeting with USEPA on June 10, 2005, Lynda Priddy indicated that Todd should conduct a design evaluation to confirm the grain-size distribution of the material to be placed on the SMA 6 habitat bench. A similar grain-size study had been performed the previous year for the habitat restoration component of the nearby Lockheed remedial action site. That study focused on determining a grain-size mixture that would meet habitat goals while optimizing material stability relative to wave action.

Coast & Harbor Engineering (Coast and Harbor) performed a study for the Todd project and evaluated wave action and erosive forces that would be acting on the habitat bench in SMA 6 (Coast and Harbor 2005). It was concluded that a material mix with a much larger grain-size component (coarser and more stable material including cobble sized rock) was the preferred material for the habitat bench. The grain-size distribution of this material, termed Type 2 Habitat Mix, is shown in Figure 3.4. The study also concluded that changes to the geometry of the buttress fill section along the eastern boundary of SMA 6 were necessary to improve hydrodynamic stability.

Following completion of planned dredging within the bench area of SMA 6 sampling and analysis determined that project cleanup criteria had not been met. Based on this information the dredge design was modified, requiring additional dredging to accommodate placement of at least 5 feet of fill within the bench area. Re-dredging was completed and confirmatory samples were collected and analyzed. Chemical results were significantly improved; however, one of the three samples still contained chemical exceedances for several chemicals. In consultation with USEPA it was determined that in lieu of conducting additional dredging the area would be covered by at least 2 feet of sand prior to the placement of 3 feet of Type 2 Habitat Mix.

4.0 Construction Activities

This section provides a detailed description and timeline of cleanup, habitat improvement, and replacement over-water structure construction activities and summarizes pertinent QA information documenting successful completion of remedial actions throughout the Site.

4.1 SEDIMENT MANAGEMENT AREAS 1 AND 2

4.1.1 Demolition of Side-launch Shipways

Demolition of the side-launch shipways, located along the Northeast Shoreline of SMA 1, was conducted between July 12 and 30, 2004. Demolition procedures were typically implemented as planned during design and results were in line with those anticipated. Two minor modifications to the planned construction methods were: (1) the concrete beam portions of the shipways were severed using concrete coring methods rather than concrete wire-saw methods, and (2) timber piles that were not intended to be fully extracted were broken off below the design dredge depth. This was done using a track-mounted hydraulic excavator operating in the dry at low-tide, rather than by using the cut-off tool or dredge bucket. Approximately 176 creosote-treated timber piles were removed from the aquatic environment during demolition of the side-launch shipways.

4.1.2 Dredging

Project dredging in the SMA 1–2 area began on August 15, 2004. Dredging activities typically progressed from shoreward areas toward more waterward areas, and as such the dredge methodically moved from the south end to the north end of the SMA 1–2 area. Initially, a complete pass was made over the SMA 1–2 area using the Cable Arm bucket to remove material that was more than 18 inches above the design dredge depth. This "overburden" dredging was designed to leave behind a fairly uniform layer of sediment that could be effectively dredged using the Cable Arm bucket, in a manner that would minimize losses, thereby resulting in a clean post-dredge surface.

The Northeast Shoreline slope was dredged following completion of overburden dredging throughout the SMA 1–2 area. The slope area was dredged to design depths using a Hawco clamshell bucket (a 14-cubic-yard open topped digging bucket). Use of the Hawco bucket was utilized instead of the Cable Arm bucket because of the large sized riprap and other slope armor on the slope and because the Cable Arm bucket is not well suited to slope dredging. Dredging of the Northeast Shoreline slope successfully met design grades, as illustrated in Figures 4.1a through 4.1c.

Final pass dredging, termed "drop cloth" dredging, of the remainder of SMAs 1 and 2 was initiated following completion of dredging at the Northeast Shoreline slope. By the time this dredging began, the project team had explored and become convinced that the large Cable Arm bucket was very effective in removing recent (typically contaminated) sediment deposits while leaving in-place native (typically clean) sediments. The Contractor was therefore directed to complete final pass dredging in all SMA 1–2 areas, other than the Northeast Shoreline slope, using Dredge Method 2 procedures (discussed in Section 3.5.1.2). Dredging of SMAs 1 and 2 was completed on October 8, 2004.

The quantity of dredge material removed from SMAs 1 and 2 is summarized in Table 4.1; the post-dredge bathymetry is presented in Figure 4.2a.

Analytical results from post-dredge sediment samples demonstrated that the flat areas in the SMAs 1 and 2, and the Northeast Shoreline slope area in SMA 1, generally met cleanup criteria. However, the Northeast Shoreline slope area in SMA 2 did not meet chemical cleanup criteria for several constituents including mercury, PCBs, and polycyclic aromatic hydrocarbons (PAHs). Bioassay testing was performed on the Northeast Shoreline slope area in SMA 2. Sample locations in the SMAs are shown in Figure 3.1. Chemical analytical results from the SMAs 1 and 2 post-dredge sediment samples are summarized in Table 3.1. The results of bioassay testing performed on the SMA 2 Northeast Shoreline slope are summarized in Table 3.1 and are discussed in Appendix D. Conclusions about the suitability of the post-dredge surface in SMAs 1 and 2 are presented and discussed in Section 5.0.

4.1.3 Under-pier Capping

Under-pier capping was implemented using special equipment purchased and assembled specifically for this project. In brief, the equipment consisted of a throwing conveyor mounted on a series of modular floats, a barge-mounted derrick crane, and a series of flat-deck material barges. To our knowledge, the methods and equipment used on this project are unique and represent the most significant under-pier capping effort anywhere in the world. Placement techniques, using the throwing conveyor, were developed through implementation of a test program that occurred in SMA 2, on the east portion of Pier 6, from October 11 through October 13, 2004. Diver survey results of the underwater areas that were capped during the test program verified that the placement equipment and techniques met or exceeded all specified criteria and tolerances (refer to Section 3.4.2).

Remaining areas beneath the eastern and western portions of Pier 6 were capped from October 18 to November 14, 2004. Additionally, the eastern portion of the Pier 6P structure was capped on October 21, 2004. Under-pier capping was conducted when tides were at or below elevation +5 feet MLLW in order to obtain sufficient headroom to accommodate the trajectory required by the throwing conveyor. In the wintertime the lowest tides typically occur during the night; therefore under-pier capping work was completed on night shifts.

QC for under-pier capping was based on "volume method" procedures, as outlined in the project specifications. This method requires that the volume of cap material to be placed over a given area be calculated based on the dimensions of the area to be capped and the required average cap thickness. Pier 6 required the placement of sand to an average thickness of 1 foot. For a given bay area on Pier 6 (the area between two adjacent piling bents, extending from approximately 8 feet outside the pier face to pier centerline) the calculated volume of cap material was 11 cubic yards. This volume of sand was therefore loaded into the hopper of the throwing conveyor. Cap thickness was then controlled by evenly "painting" the water surface directly above the area to be capped with the stream of cap material thrown from the conveyor until the entire volume of cap material in the hopper had been placed. The Contractor used this procedure for all under-pier capping efforts and reported the volume of capping material placed and the number of bays capped in their daily reports. The volume of cap sand placed beneath Pier 6 is summarized in Table 4.2, along with the calculated average cap thickness. Additionally, USEPA performed a diver survey of the capped areas beneath Pier 6. Diver survey results indicated capping beneath Pier 6 met project specifications for distribution and thickness (Appendix A).

4.1.4 In-water Filling

Reconstruction of the Northeast Shoreline, following dredging, was accomplished by placing imported fill using a barge mounted derrick crane and a bottom-dump skip box. The Northeast Shoreline slope in SMAs 1 and 2 required placement of two types of materials: (1) a gravelly sand, placed immediately above the post dredge surface, and (2) riprap, placed above the gravelly sand. The construction process typically involved placing material from the bottom of the slope and progressively working upslope. Placement iteratively involved building a riprap berm at the toe of the slope and then filling the zone between the riprap berm and the adjacent face of the slope with gravelly sand. The design of the fill slope in SMA 2 was modified following a determination that post-dredge sediments along the slope did not meet project chemical cleanup criteria. In brief, the design revision provided a thicker section of gravelly sand between the post-dredge surface and the overlying riprap armoring, allowing the fill to act as a permanent cap. Details about this design change are provided in Appendix D.

Filling of the Northeast Shoreline slope, using the two materials, was a very methodical and time-consuming process. Fill placement began on September 29, 2004, approximately 2 weeks after slope dredging was completed, and was conducted continuously until completion on February 17, 2005.

Post fill bathymetric surveys of the Northeast Shoreline slope were conducted as slope construction progressed to confirm that fill was being placed to proper grades. A plan view of the post-fill bathymetry of the shoreline slope is provided on Figure 4.2b and cross-sections of the final post-fill grades are provided on Figures 4.1a through 4.1c. The quantities of fill materials (in tons) placed at this location are summarized in Table 4.3.

Placement of boundary sand material was completed in SMA 1 along the eastern end of the Site as indicated in Figure 3.2. Approximately 180 tons of boundary sand was placed at this location where dredge cuts exceeded 3 feet in depth along the Site boundary for approximately 100 feet. Actual boundary sand placement rates, summarized in Table 4.4, typically exceeded the specified rate of 1.07 cubic yards per linear foot.

Habitat mix was placed over the riprap surface above elevation –10 feet MLLW following completion of reconstruction of the Northeast Shoreline slope. Actual habitat mix placement rates, summarized in Table 4.3, typically exceeded the specified rate of 25 tons per 1,000 square feet.

4.2 SEDIMENT MANAGEMENT AREA 3

4.2.1 Dredging

Initial dredging in SMA 3 was conducted, using Dredge Method 2 procedures, between approximately October 11 and November 11, 2004. Unfortunately, post-dredge sediment sampling and analysis demonstrated that significant areas within the SMA did not meet cleanup levels. Based on these results the entire SMA, except for the western portion of the slope at the north end of the SMA, was re-dredged using Dredge Method 2 procedures. Re-dredging took place on a double-shift basis between November 30 and December 14, 2004. Post re-dredge sediment sampling and analysis showed significant improvement, however several samples collected in the southern portion of the SMA still exceeded cleanup criteria for mercury and/or PCBs. These areas were re-dredged again from February 8 to February 11, 2005. Follow-on sampling and analysis indicated that three samples still had mercury concentrations greater than the cleanup level, however, exceedances were for mercury alone, and at concentrations less than 1 ppm in two of the three samples. The area where mercury exceeded 1 ppm was re-dredged one more time on February 22, 2005.

Analytical results of the final post-dredge sediment surface are presented in Table 3.1. Sample locations are shown in Figure 3.1. A discussion of the suitability of the post-dredge sediment surface in SMA 3 is provided in Section 5.0.

The quantity of material dredged from SMA 3 is summarized in Table 4.1, and the post-dredge bathymetry of this area is presented in Figure 4.2a.

4.2.2 Under-pier Capping

A shotcrete cap covering the large debris mound located beneath the very southern portion of Pier 6P was constructed from August 5 through August 16, 2004. The capping effort was conducted in the dry, during periods of low tide, using methods accomplished in accordance with plans and specifications. A total of 37.5 cubic yards of shotcrete was placed at this location.

Areas beneath Pier 6P were capped with sand during the period from November 11 to November 15, 2004. Areas beneath the eastern and western portions of Pier 5 were capped from November 16, 2004 to January 29, 2005.

QC for under-pier capping was based on "volume method" procedures, as outlined in the project specifications. Calculated volumes of cap sand, corresponding to an average 1-foot thickness, was placed at Pier 6P with a concerted effort to throw the sand as far beneath the platform structure as possible. Given the irregular geometry of the Pier 6P structure, it was difficult to determine typical placement bay dimensions and volumes. A diver survey of the capped area beneath Pier 6P was performed by USEPA after completion of under-pier cap placement activities. Results indicated that capping beneath Pier 6P generally reached 50 to 75 feet from the face of the platform. The southern internal area beneath Pier 6P, therefore, likely did not receive the specified thickness of cap materials. Diver survey results indicated capping beneath Pier 6P met project specifications for distribution and thickness (Appendix A). Conclusions about the adequacy of capping of the Pier 6P area are presented in Section 5.0 and the volume of cap sand placed beneath the Pier 6P structure, along with the calculated average cap thickness, is summarized in Table 4.5.

For under-pier capping activity at Pier 5, 100 cubic yards of cap sand, corresponding to an average cap thickness of 3 feet, was placed at every bay along the eastern and western sides of Pier 5. The Contractor provided daily reports of the volume of capping material placed and the number and location of bays capped. The volume of cap sand placed beneath Pier 5, along with the calculated average cap thickness, is summarized in Table 4.6.

Following completion of the various iterations of dredging and re-dredging in SMA 3, additional capping sand was applied to the areas immediately adjacent to the western face of Pier 6, the northern and western face of Pier 6P, and the eastern face of Pier 5. This supplemental capping effort was accomplished by discharging an approximate 10-foot wide by 12- to18-inch-thick layer of sand, from the face of the pier waterward. Placement of this material ensured the integrity of the portion of the caps extending from beneath the piers to cover the boundary of the limits of dredging adjacent to pier structures. The volume of additional cap sand material placed adjacent to the western face of Pier 6, the northern and western face of Pier 6P, and the eastern face of Pier 5 is summarized in Table 4.3.

4.2.3 In-water Filling

In-water fill work conducted in SMA 3 included placement of habitat mix over slope armoring along the southern boundary of the SMA, and filling of subtidal depression areas following completion of dredging.

Habitat mix was placed on November 30, 2004. Table 4.3 summarizes placement quantities, which document that average coverage rates exceeded specified rates.

Re-dredging of SMA 3 created two unanticipated subtidal depression areas, shown on Figure 3.2. These areas, as well as the original depression adjacent to Pier 5E, were filled on February 8, 9, and 10, 2005. The bathymetry depicted on Figure 4.2a documents the post-remediation condition of SMA 3 (e.g., both post-dredge and post-fill), indicating that the depressions were filled, thereby eliminating "bathtub" conditions. The quantity of subtidal depression fill placed in SMA 3 is summarized in Table 4.3.

4.3 SEDIMENT MANAGEMENT AREA 4

4.3.1 Dredging

Initial dredging in SMA 4 was conducted using Dredge Method 2 procedures, between approximately December 16, 2004 and January 14, 2005. Post-dredge sediment sampling and analysis revealed that approximately 50 percent of the SMA (predominantly in the southern and central areas) did not meet cleanup levels. These areas were re-dredged using Dredge Method 2 procedures between January 17 and January 21, 2005. Post re-dredge sediment sampling and analysis showed significant improvement; however, two samples still identified exceedances for metals and PCBs. These areas were re-dredged again on February 2 and 3, 2005. Follow-on sampling and analysis indicated that all areas met cleanup criteria.

Analytical results of the final post-dredge sediment surface are presented in Table 3.1. Sample locations are shown in Figure 3.1. The quantity of material dredged from SMA 4 is summarized in Table 4.1, and post-dredge bathymetry of this SMA is presented in Figure 4.2c. Conclusions about the suitability of the post-dredge surface in SMA 4 are presented and discussed in Section 5.0.

4.3.2 Under-pier Capping

Areas beneath the eastern and western portions of Pier 4N were capped between December 13, 2004 and February 24, 2005.

QC for under-pier capping was based on "volume method" procedures, as outlined in the project specifications. Seventy-seven cubic yards of cap sand, corresponding to an average cap thickness of 3 feet, was placed in every bay at Pier 4N. The Contractor provided daily reports of the volume of capping material placed and the number of bays capped. The volume of cap sand placed beneath Pier 4N, along with the calculated average cap thickness, is summarized in Table 4.7.

4.3.3 In-water Filling

In-water fill work conducted in SMA 4 was limited to placement of habitat mix over riprap along the slope on the southern boundary of the SMA. Habitat mix was placed on January 31, 2005. Placement quantities, summarized in Table 4.3, document that average coverage rates exceeded those specified.

4.4 SEDIMENT MANAGEMENT AREA 5

4.4.1 Dredging

Overburden removal dredging in SMA 5 was conducted, using Dredge Method 2 procedures, between approximately November 11 and November 15, 2004. Drop cloth dredging was then conducted intermittently in SMA 5 between November 16 and January 26, 2005 (during this time dredging was also being conducted in SMA 3 and 4 to meet critical shipyard operation requirements). Post-dredge sediment sampling and analysis identified one sample in SMA 5 that exceeded cleanup criteria. This area was re-dredged, using Dredge Method 2 procedures, on January 26 and 27, 2005. Post re-dredge sediment sampling and analysis showed significant improvement, however this area still exceeded the cleanup criteria for mercury. This area was re-dredged again from February 18 to February 21, 2005. Post re-dredge sediment sampling and analysis showed that all areas met cleanup criteria.

Analytical results of the final post-dredge sediment surface are presented in Table 3.1. Sample locations are shown in Figure 3.1. The quantity of dredge material removed from SMA 5 is summarized in Table 4.1, and post-dredge bathymetry is presented in Figure 4.2c. Conclusions about the suitability of the post-dredge surface in SMA 5 are presented and discussed in Section 5.0.

4.4.2 Under-pier Capping

Under-pier capping at Pier 4N is discussed above in Section 4.3.2.

4.4.3 In-water Filling

In-water fill work conducted in SMA 5 included placement of fill in a subtidal depression area and placement of boundary sand.

The subtidal depression area in SMA 5 was filled on February 21, 2005. The subtidal depression was filled using a derrick barge and a clamshell bucket. The bathymetry depicted on Figure 4.2c documents the post-remediation condition of SMA 5 (e.g., both post-dredge and post-fill). The bathymetry shows that the subtidal depression at the north end of SMA 5 has been completely filled.

Boundary sand was placed along the TSSOU boundary in SMA 5 at locations where dredge cuts exceeded 3 vertical feet, as identified by a Site boundary survey performed on February 17, 2005. Approximately 330 tons of boundary sand was placed in SMA 5 on February 23, 2005. Boundary sand was placed using a clamshell bucket to uniformly discharge the sand, in accordance with project specifications. Actual boundary sand placement rates, summarized in Table 4.4, typically exceeded the specified rate of 1.07 cubic yards per linear foot.

Quantities of in-water fill materials placed in SMA 5 are summarized in Table 4.3.

4.5 SEDIMENT MANAGEMENT AREA 6

4.5.1 Demolition of Pier 4S

Demolition of Pier 4S, located in SMA 6, was conducted between June 1 and August 17, 2005. Demolition procedures were typically implemented as planned and results were in line with those anticipated. Pier demolition consisted of removing the existing timber superstructure and then removing the creosote-treated timber support piling, primarily by fully extracting the piles. Piles were broken off at or below the post-dredge mudline where full extraction was not possible.

Demolition of Pier 4S superstructure was conducted by RW Rhine using track-mounted excavators equipped with various tongs, grabs, and buckets. Asphalt and concrete deck surfaces were swept and then removed and transported off-site via truck to a recycling facility. Demolition debris from the pier superstructure was loaded onto trucks for off-site transport to a recycling or disposal facility.

Approximately 25 survey monuments were established at the top of the bulkhead along the eastern boundary of the Pier 4S structure and routine surveys were implemented to monitor horizontal and vertical movement of the bulkhead as the pier demolition process was conducted. Buttress fill was placed waterward of the bulkhead as the pier was demolished to maintain stability of the bulkhead during the demolition process (this work is further discussed in

Section 4.5.3). Survey monitoring indicated that only minimal movement (typically less than 1 inch) was detected throughout the period of this work.

Pile removal was conducted by GCC using a vibratory extractor to loosen and partially remove the piles. A clamshell bucket was then used to grab and fully extract the piles and to place the piles onto a barge, which was then transported off-site. Approximately 1,800 pilings were removed, the vast majority of which were fully extracted. Piles were occasionally unable to be fully extracted because of pile breakage at or below the mudline. However, subsequent dredging of the Pier 4S footprint typically resulted in full extraction of these piles as well.

4.5.2 Dredging

Dredging in SMA 6 was conducted during the 2005-2006 construction season. The first round of dredging of sediment and co-mingled debris within SMA 6 was conducted using Dredge Method 1 procedures between August 15 and September 13, 2005. Post dredge sediment sampling and analysis showed that all samples exceeded the cleanup criteria. The two samples that were collected from the steep slope area contained only minor exceedances of the cleanup criteria for mercury (e.g., 0.50 mg/kg and 0.64 mg/kg versus cleanup criteria of 0.41 mg/kg). With USEPA's concurrence the steep slope area was not re-dredged.

In accordance with the design change for the SMA 6 bench area, described in Section 3.4.3.2, the bench area was re-dredged to new design depths using Dredge Method 1 methods between September 16 and September 23, 2005. Post re-dredge sediment sampling and analysis showed significant improvement; however, all three areas, TSP-06-06, TSP-06-07, and TSP-6-08, still contained one or more chemicals exceeding cleanup criteria. With USEPA's concurrence and based on the deepened dredged depth it was determined that in lieu of conducting additional dredging the area would be covered by at least 2 feet of sand and 3 feet of Type 2 Habitat Mix.

Analytical results of the final post-dredge sediment surface are presented in Table 3.1. Sample locations are shown in Figure 3.1. The quantity of dredge material removed from SMA 6 is summarized in Table 4.1, and post-dredge bathymetry is presented in Figure 4.2d. Conclusions about the suitability of the post-dredge surface in SMA 6 are presented and discussed in Section 5.0.

4.5.3 In-water Filling

In-water fill in SMA 6 included construction of the buttress fill adjacent to the Pier 4S bulkhead, construction of a habitat bench, and armoring of the steep slope waterward of the habitat bench.

The buttress fill was constructed using clean riprap materials intermittently between July and November 2005. The buttress fill was partially constructed as demolition progressed and was completed following dredging of adjacent areas. Once placement of the buttress fill was complete, the top of the riprap was top-dressed with habitat mix consistent with methods described in the RAWP.

The steep slope that extended waterward from the western boundary of the habitat bench was armored with a minimum of 3-feet of clean riprap to promote stability of the slope and the adjacent habitat bench. This work was conducted by GCC using a bottom dump skip box between October 10 and November 28, 2005.

The habitat bench was constructed in accordance to the revised design (described in Section 3.4.3.2). The habitat bench consists of a minimum 2-foot thickness of sand and a 3-foot thickness of Type 2 Habitat Mix. Sand was placed to a pre-determined depth using a clamshell bucket between November 17 and November 23, 2005. A post sand-placement bathymetric survey of the habitat bench verified that appropriate sand thicknesses had been achieved.

A minimum 3-foot-thick layer of Type 2 Habitat Mix was then placed on top of the sand in the habitat bench using a bottom dump skip box. The habitat mix was placed between November 28 and December 2, 2005. A post placement bathymetric survey was used to verify that the surface of the habitat bench met design grades. Cross sections of the habitat bench are shown in Figure 4.3. Throughout this construction sequence, field visits were made to the respective quarries to verify the quality of the riprap and Type 2 Habitat Mix.

A plan view of the post-fill conditions is provided on Figure 4.2e. The quantities of fill materials (in tons) placed at this location are summarized in Table 4.3.

4.6 SEDIMENT MANAGEMENT AREA 7

4.6.1 Dredging

Dredging in SMA 7 was conducted during both the 2004-2005 and the 2005-2006 construction seasons. Dredging conducted during the 2004-2005 season was largely "fill-in" work, used to keep the dredge busy during periods when access to target areas in SMAs 3 through 5 was not available. Overburden removal dredging in SMA 7 was conducted using Dredge Method 2 procedures between November 11 and November 15, 2004. Drop cloth dredging was then conducted intermittently in the northern portion of SMA 7 between November 16 and January 26, 2005 (during this time dredging was also being conducted in SMAs 3 and 4 to meet critical shipyard operation requirements). Post dredge sediment sampling and analysis showed that the northern section of SMA 7 (e.g., sample TSP-07-07) met cleanup criteria. This area was re-sampled during the 2005-2006 construction season following completion of all dredging in SMA 7. Sediment sampling and analysis again showed that this area met cleanup criteria.

During the 2005-2006 construction season, overburden removal dredging continued throughout the remainder of SMA 7 using Dredge Method 2 procedures, between September 13 and September 23, 2005 (during this time dredging was also being conducted in SMA 6 to meet critical scheduling requirements). Drop cloth dredging was conducted throughout the remainder of SMA 7 between September 23 and September 30, 2005. Post dredge sediment sampling and analysis showed that five of seven samples exceeded cleanup criteria. Two of the samples contained only minor exceedances of the cleanup criteria for mercury (e.g., 0.43 mg/kg and 0.53 mg/kg versus cleanup criteria of 0.41 mg/kg). With USEPA's concurrence these areas were not re-dredged. The other three areas were re-dredged from October 6 to October 11, 2005. Post re-dredge sediment sampling and analysis showed that all areas met cleanup criteria.

Analytical results of the final post-dredge sediment surface are presented in Table 3.1. Sample locations are shown in Figure 3.1. The quantity of dredge material removed from SMA 7 is summarized in Table 4.1, and post-dredge bathymetry is presented in Figures 4.2c and 4.2d. Conclusions about the suitability of the post-dredge surface in SMA 7 are presented and discussed in Section 5.0.

4.6.2 In-water Filling

In-water fill work conducted in SMA 7 included placement of fill in a subtidal depression area and placement of boundary sand.

A subtidal depression area in the north end of SMA 7 was filled from February 22 to February 25, 2005 and on December 5, 2005. The bathymetry depicted on Figures 4.2c and 4.2d documents the post-remediation condition of SMA 7 (e.g., both post-dredge and post-fill). The bathymetry demonstrates that the subtidal depression at the north end of SMA 7 has been completely filled.

Sand was placed along the TSSOU boundary in SMA 7 at locations where dredge cuts exceeded 3 vertical feet, as identified by a Site boundary survey performed on November 18, 2005. Approximately 85 tons of boundary sand was placed on December 1, 2005. Sand was placed, using a clamshell bucket to uniformly discharge the sand, in accordance with project specifications. Actual boundary sand placement rates, summarized in Table 4.4, typically exceeded the specified rate of 1.07 cubic yards per linear foot.

Quantities of in-water fill materials placed in SMA 7 are summarized in Table 4.3.

4.7 SEDIMENT MANAGEMENT AREA 8

4.7.1 Demolition of Pier 2

Demolition of Pier 2, located in SMA 8, was conducted between October 24 and December 9, 2004. Demolition procedures were typically implemented as planned and results were in line with those anticipated. The only modification to planned construction methods was that a significant percentage of the pier decking materials were transported off-site by barge, rather than by truck as originally anticipated. Approximately 850 pilings were removed as a part of the demolition, the vast majority of which were fully extracted. Batter piles were the only piles that could not always be fully extracted. These piles sometimes broke off at or below the mudline. However, subsequent dredging of the pier footprint in many cases resulted in these piles being fully extracted, or at a minimum in breaking the remaining piles off flush with, or below the mudline.

4.7.2 Removal of the Building Berth Decking

Removal of the decking from the most waterward portion of the building berth (west of the north-south trending bulkhead) was conducted on August 17 and August 18, 2005. Support piling were not removed, allowing for future deck replacement. Deck removal procedures were typically implemented as planned and results were in line with those anticipated. The only modification to planned construction methods was that the decking materials were transported off-site by barge, rather than by truck as originally anticipated.

4.7.3 Dredging

Dredging in SMA 8 was conducted during both the 2004-2005 and the 2005-2006 construction seasons. Dredging conducted during the 2004-2005 season was largely "fill-in" work, used to keep the dredge busy during periods when access to target areas in SMAs 3 through 5 was not available. Overburden removal dredging in SMA 8 was conducted using Dredge Method 2 procedures in late January and much of February 2005.

During the 2005-2006 construction season, drop cloth dredging in SMA 8 was conducted using Dredge Method 2 procedures between October 6 and October 20, 2005. Post dredge sediment sampling and analysis showed that five of eight samples exceeded cleanup criteria. These areas were re-dredged from October 21 to October 27, 2005. Post re-dredge sediment sampling and analysis showed significant improvement; however, three areas still exceeded cleanup criteria. Two of the samples contained minor exceedances of the cleanup criteria, one for mercury and one for LPAHs (e.g., 0.43 mg/kg mercury versus cleanup criteria of 0.41 mg/kg mercury and 9,219 ug/kg LPAHs versus cleanup criteria of 5,200 ug/kg LPAHs). With USEPA's concurrence, these areas were not re-dredged. The other area was re-dredged for a second time on November 15 and November 16, 2005. Post dredge sediment sampling and analysis showed that this area met cleanup criteria.

Analytical results of the final post-dredge sediment surface are presented in Table 3.1. Sample locations are shown in Figure 3.1. The quantity of dredge material removed from SMA 8 is summarized in Table 4.1, and post-dredge bathymetry is presented in Figure 4.2d. Conclusions about the suitability of the post-dredge surface in SMA 8 are presented and discussed in Section 5.0.

4.7.4 Under-pier Capping

Areas beneath Piers 1, 2P, 3 were capped between November 2, 2005 and November 10, 2005. The area below the portion of the building berth where decking had been removed was also capped at this time.

Under-pier capping was accomplished using the methods described in Section 4.1.3. QC for under-pier capping was based on "volume method" procedures, as outlined in the project specifications. This method requires that the volume of cap material to be placed over a given area be calculated based on the dimensions of the area to be capped and the required average cap thickness. For a given bay area on Piers 1, 2P, and 3 (the area between two adjacent piling bents, extending from approximately 8 feet outside the pier face to 40 feet inside the pier face) the calculated volume of 1 foot of cap material was 16, 26 and 21 cubic yards, respectively. For the lower portion of the building berth, the area was divided into sections 10 feet wide and 60 feet long. The calculated volume for 1 foot of cap material was 22 cubic yards. These volumes of sand were therefore loaded into the hopper of the throwing conveyor. Cap thickness was then controlled by evenly "painting" the water surface directly above the area to be capped with the stream of cap material thrown from the conveyor until the entire volume of cap material in the hopper had been placed. The Contractor used this procedure for all under-pier capping efforts and reported the volume of capping material placed and the number of bays capped in their daily reports. The volume of cap sand placed beneath Piers 1, 2P, 3 is summarized in Table 4.8, along with the calculated average cap thickness.

In addition, a diver survey of the capped area beneath Pier 3 was performed by Research Support Services on November 4, 2005 following completion of under-pier cap placement activities at Pier 3. Results indicated that capping beneath Pier 3 extended to the riprap slope, 45 to 50 feet from the face of the pier and that overall, the average under-pier sand cap thickness was 11.4 inches within 40 feet of the face of the pier (the designed sand cap width). Diver survey results indicated capping beneath Pier 3 met project specifications for distribution and thickness and can be found in Appendix A.

4.8 SEDIMENT MANAGEMENT AREA 9

4.8.1 Dredging

Dredging in SMA 9 was conducted during both the 2004-2005 and the 2005-2006 construction seasons. Dredging conducted during the 2004-2005 season was largely "fill-in" work, used to keep the dredge busy during periods when access to target areas in SMAs 3 through 5 was not available. Overburden removal dredging in SMA 9 was conducted using Dredge Method 2 procedures between February 24 and February 25, 2005.

During the 2005-2006 construction season, overburden dredging was completed using Dredge Method 2 procedures on October 3 and October 5, 2005. Drop cloth dredging in SMA 9 was conducted between October 28 and November 2, 2005. Post dredge sediment sampling and analysis showed that one of three samples exceeded the cleanup criteria. This area was re-dredged on November 10, 2005 and follow-on sediment sampling and analysis showed that this area met cleanup criteria.

Analytical results of the final post-dredge sediment surface are presented in Table 3.1. Sample locations are shown in Figure 3.1. The quantity of dredge material removed from SMA 9 is summarized in Table 4.1, and post-dredge bathymetry is presented in Figure 4.2d. Conclusions about the suitability of the post-dredge surface in SMA 9 are presented and discussed in Section 5.0.

4.8.2 Under-pier Capping

The area beneath Pier 1A was capped on November 10, 2005. Under-pier capping in SMA 9 was conducted in conjunction with the under-pier capping conducted in SMA 8.

Under-pier capping was accomplished using the methods described in Section 4.1.3. QC for under-pier capping was based on "volume method" procedures, as outlined in the project specifications. This method requires that the volume of cap material to be placed over a given area be calculated based on the dimensions of the area to be capped and the required average cap thickness. For Pier 1A, the calculated volume of 1 foot of cap material was 70 cubic yards. This volume of sand was therefore loaded into the hopper of the throwing conveyor. Cap thickness was then controlled by evenly "painting" the water surface directly above the area to be capped with the stream of cap material thrown from the conveyor until the entire volume of cap material in the hopper had been placed. The Contractor used this procedure for all under-pier capping efforts and reported the volume of capping material placed in their daily reports. The volume of cap sand placed beneath Pier 1A is summarized in Table 4.8.

4.8.3 In-water Filling

In-water fill work conducted in SMA 9 consisted of placement of boundary sand. Sand was placed along the TSSOU boundary in SMA 9 at locations where dredge cuts exceeded 3 vertical feet, as identified by a Site boundary survey performed on November 18, 2005. Approximately 150 tons of boundary sand was placed between December 1 and December 5 2005. Sand was placed using a clamshell bucket to uniformly discharge the sand in accordance with project specifications. Actual boundary sand placement rates, summarized in Table 4.4, typically exceeded the specified rate of 1.07 cubic yards per linear foot.

Quantities of in-water fill materials placed in SMA 9 are summarized in Table 4.3.

4.9 SEDIMENT TRANSLOAD, TRANSPORTATION, AND DISPOSAL

Dredged material and co-mingled debris were transported by barge to T-25 where the material was off-loaded, transloaded to rail containers, and transported to and disposed of at the Roosevelt Landfill by RDC. A total of 202 hopper barges were transported to T-25 throughout the project; 153 barges during the 2004-2005 construction season and 49 barges during the 2005-2006 construction season. Sediment off-loading, transloading, transportation, and disposal practices were accomplished in general accordance with the BMPs described in the Final Design Report and the RAWP (FSM Team 2004; FSM 2004).

4.9.1 Typical T-25 Operations

Hopper barges loaded with dredged material (typically 1,300 to 1,700 tons per barge) were transported from the TSSOU by tugboat to T-25 for transfer to the transload facility. Upon receipt of the dredged material, RDC prepared a Disposal Certificate that identified the generator site and owner, the date the barge was received, the weight of material off-loaded from the barge, the sequential number of the barge, and a certification that RDC took title and ownership of the material and disposed of the material at the Roosevelt Regional Landfill facility. Copies of the Certificates of Disposal for the 202 barge loads of sediment and shipyard waste disposed of during the project are provided in Appendix A.

All site activities, including barge off-loading, surge pile management, transloading of material to railcars, and stormwater and drainage water management, were conducted by RDC subcontractors. Wilder Construction operated the first facility during the 2004-2005 season and Clearcreek Contractors operated the facility during the 2005-2006 season. During the 2004-2005 season the T-25 facility served several sediment remediation customers, including the Todd, Lockheed Shipyards, East Waterway, and Terminal 46 projects. During the 2005-2006 construction season the T-25 facility primarily served only Todd sediment remediation project (one barge of sediment from the East Waterway was off-loaded and transloaded through the facility near the end of the season).

Sediment and co-mingled debris barged to the Site was off-loaded using a long reach backhoe and/or a crane operated clamshell bucket. The buckets used to transfer material from the barge to the upland never traveled over open water. To prevent material from entering the water during the off-load process a metal apron was constructed that extended from the face of the pier over the barge. The apron was pitched such that sediment that fell onto the apron flowed toward the adjacent holding cell. Geotextile fabric was draped from the waterward edge of the apron down into the barge to prevent sediment lost during off-load operations from falling into the waterway.

Off-loaded material was initially deposited into a holding cell located immediately adjacent to the pier face. Off-loaded material was then transferred by front-end loader either to a larger surge area located further inland or directly into railcars. Surge areas consisted of stacked ecology block walls that encompassed and contained the sediment. Stormwater and drainage water generated within the containment area was collected and routed via a vacuum pump system to a stormwater retention pond. Retained water was pre-treated using a sand filtration and carbon adsorption system and discharged under permit to the King County sewage system.

Floyd|Snider and USEPA conducted periodic inspections of the T-25 facility to confirm that BMPs for these activities were routinely implemented.

4.9.2 Cleanup of the T-25 Facility

The T-25 facility was cleaned at the end of each season's dredging activities. At the completion of the 2004-2005 season the T-25 facility was decommissioned, cleaned, and relocated to the southern portion of the T-25 site to accommodate the relocation of Matson Navigation Company from Terminal 18 to T-25. At the end of the 2005-2006 season the T-25 facility was cleaned and left in place for potential future use. Lynda Priddy (USEPA) toured the T-25 facility on February 23, 2006 and accepted the site as being adequately cleaned.

Site cleanup activities consisted of the following actions:

- Ecology Blocks (used to contain sediment).
  - Pressure washed to remove sediments.
  - Wash water collected and routed to the retention pond.
- Asphalt Pavement (all paved surfaces within containment area).
  - Pressure washed to remove sediments.
  - Wash water collected and routed to the retention pond.
- Railroad Lines (within containment area).
  - Removed debris from geotextile fabric covering railroad ballast.
  - Rolled up geotextile fabric in sections and placed in containers for disposal at Roosevelt Regional Landfill.
  - Hand removed residual sediment around railroad tracks, including broken/damaged asphalt areas.
  - Pressure washed area, collected wash water routed to retention pond.

  * All ballast material used during the first year's operation was physically washed to remove sediment. Ballast was then relocated to the southern portion of T-25 where it was reused for the rail lines erected for the second season.
  * All ballast material used to support rail lines during the second season will be disposed of at Roosevelt Regional Landfill upon site final demobilization (to occur at the end of the T-25 lease term).
- Utility Vaults & Catch Basins (within containment area).
  * Removed packing material and sediments.
  * Pressure washed interior surfaces.
  * Wash water collected and routed to retention pond.
- Water Treatment System.
  * Removed settled solids from retention pond using vactor trucks and hand shovels.
  * Removed spent carbon from carbon filters and sand from sand filters.
  * Trucked collected materials to Rabanco's transfer facility at 3rd & Lander in Seattle for disposal at Roosevelt Regional Landfill.

4.10 REPLACEMENT OVER-WATER STRUCTURES

As discussed above, Pier 2, Pier 4S, and the side-launch shipways were demolished to provide access for dredging of underlying contaminated sediments. Additionally, project source control actions required that Todd stop using their old wooden dry dock (e.g., Dry Dock 2).

To allow for on-going and future productive shipyard operation, USEPA agreed that Todd could replace those facilities that were determined critical to the shipyard following completion of cleanup actions. Replacement structures were evaluated with the biological opinion and approved as part of the review by the City of Seattle and resource agencies for substantive compliance with permit requirements. As construction has proceeded, Todd has reevaluated their financial resources and shipyard operational requirements, and developed a revised plan for these construction items. The rationale for the work remained intact, but the scope was reduced to lessen the overall expense to the shipyard, and to better adapt to anticipated business needs. The result of these changes is less over-water coverage, removal of more creosote-treated piling, no additional pile installation, and less aquatic impact from berth deepening.

Structures constructed or purchased to replace those demolished or decommissioned include the Pier 4N Fender System, the North Trestle, the Ship Launch Trestle, and the AFDM-10 Dry Dock. These structures are shown on Figure 4.4 and are discussed below.

4.10.1 North Trestle and Pier 4N Fender System

The original design envisioned rebuilding Pier 4S and replacing the fenders on Pier 4N once cleanup actions were complete. As the project progressed Todd made the decision, based on financial constraints, not to rebuild Pier 4S. To provide continued vehicular and utility access to

Pier 4N, Todd constructed a simple trestle that spans from the south end of Pier 4N to the adjacent uplands. This trestle consists of a cast-in-place concrete deck supported by steel piles. The trestle was constructed in two phases; Phase 1 was constructed during the fall and early winter of 2004-2005 and Phase 2 was constructed during the fall and early winter of 2005-2006.

The existing creosote-treated timber pile fender system along the west side of Pier 4N was removed and replaced with a new steel pile fender system during the 2004-2005 construction season.

4.10.2 Ship Launch Trestle

Todd originally planned to construct a replacement ship launching facility at the Northeast shoreline of the shipyard facility to replace the launch facility removed to provide access for cleanup actions. Based on shipyard business objectives for future new ship construction Todd revised the planned location of this facility. The replacement ship launch trestle was constructed on the west side of the shipyard, extending from Building T-72, in the footprint of the former Pier 4S structure. Construction of this structure was completed by the end of the 2006-2007 in-water construction season.

4.10.3 Dry Dock Replacement and Related Fender Construction

Todd demolished and disposed of the old wooden Dry Dock 2 located at Pier 6W and replaced it with a newly purchased metal surfaced dry dock. The replacement dry dock was originally planned to be located at Pier 6E. However, to minimize project costs and environmental impacts the replacement dry dock was positioned at Pier 5E. The revised location for the replacement dry dock required the following revisions to the original design for construction of replacement over-water structures:

- Additional deepening originally planned at Pier 6E (below the cleanup depths to provide a berth elevation of –45 feet MLLW) was not necessary based on the Pier 5E dry dock location and was not completed.
- Removal of two sections of Pier 6 and construction of strengthening "inserts" to support anchoring dolphins was not necessary based on the Pier 5E dry dock location and was not completed.
- Construction of new anchoring dolphins at Pier 6E was not necessary based on the Pier 5E dry dock location and was not completed.
- Construction of a new platform and ramp just east of Pier 6 to provide access to the relocated dry dock was not necessary based on the Pier 5E dry dock location and was not completed.
- Construction of new steel pile fendering at Pier 5E was necessary to accommodate dry dock moorage. This construction was completed during the 2006-2007 in-water construction season.
- Construction of new steel pile fendering and dolphin at Pier 6E was necessary to provide for ship berthing previously occurring at Pier 5E. This construction was completed during the 2006-2007 in-water construction season.

- Construction of new steel pile fendering at Pier 6W was necessary to accommodate ship moorage at the location of the old Dry Dock 2. This construction occurred during the 2006-2007 in-water construction season.

5.0 Final Inspections, Achievement of Performance Standards, Institutional Controls, and Certification

5.1 INSPECTIONS

As required by the Remedial Action SOW, an Interim Construction Inspection was performed within 30 days after completion of work for both the 2004–2005 and 2005-2006 in-water construction seasons. The Interim Construction Inspection for work completed during the 2004-2005 season was held on March 7, 2005, and consisted of an on-site meeting with USEPA to review and discuss the status of work performed and conclusions about completeness of remedial action construction in SMAs 1–5. The Interim Construction Inspection for work completed during the 2005-2006 season was held on February 23, 2006, and consisted of a meeting at T-25 with USEPA to review and discuss the status of cleanup work performed at T-25 and conclusions about completeness of remedial action construction in SMAs 6–9. A Final Construction Inspection Meeting was held on July 11, 2007, following completion of 2006-2007 construction of shipyard infrastructure replacement.

5.2 PERFORMANCE STANDARDS

The following sections summarize remedial action construction performed at the TSSOU and describes how the remedial action objective and requirements, stated in the ROD (USEPA 1996) and Remedial Action SOW (USEPA 2003c), have been achieved.

5.2.1 Dredging

In order to meet the remedial action objective, contaminated sediments and shipyard waste have been removed from the open-water areas of SMAs 1–9 by dredging to depths where contaminant concentrations are less than chemical and/or biological SQS as defined by the Washington State SMS (Chapter 173-204 WAC; Ecology 1995). The dredging sequence is discussed in Section 4.0. Dredging was performed following the construction quality assurance procedures stated in the RAWP (FSM 2004). Sediment samples were collected from the post-dredge surface and compared to SQS to verify that performance standards were achieved. Sediment sampling and analysis was performed in accordance with the RASAP and QAPP (Appendix B of the RAWP; FSM 2004).

5.2.1.1 Post-dredge Confirmational Sediment Samples

The RAWP states that a final round of sediment confirmation sampling could be conducted at the end of the season to address concerns of potential recontamination of clean post-dredge surfaces from adjacent dredge areas (FSM 2004). However, based on the representativeness of the progress sediment samples collected throughout both the 2004-2005 and the 2005-2006 seasons from post-dredge surfaces, Todd and USEPA agreed that no additional end of season confirmation samples would need to be collected. Based on construction experience and analytical results, it was determined that the progress sediment samples collected from the post-dredge surface on an SMA-by-SMA basis as the work progressed would be considered representative of current conditions at the TSSOU based on the following justification:

- Dredging was consistently conducted using equipment and procedures that minimized the potential for loss of sediment and therefore minimized the potential for resulting recontamination of adjacent areas. All dredging and barge dewatering was conducted in accordance with the BMPs described in the RAWP. Wherever possible, dredging was conducted using the 24-cubic-yard Cable Arm environmental clamshell bucket that is closed, vented, and sealed in order to minimize the release and redistribution of dredged material to the water column during dredging.
- Progress sampling and construction observation did not indicate that recontamination of adjacent dredged areas was occurring. Progress sampling performed in each SMA was typically performed following completion of dredging in that SMA. Progress sample results consistently showed that subsequent dredging adjacent to an already-dredged area did not recontaminate the clean area.
- The progress samples fully meet all RASAP requirements for confirmational samples. At some other sites, progress samples have been taken with a shorter list of "indicator chemicals", or with a scaled-back sampling protocol. At the TSSOU, however, all post-dredge progress sediment samples were collected and analyzed in strict accordance with the all of the USEPA approved requirements detailed in the RASAP and QAPP for conformational samples, including:
  - Sample frequency, location, and procedures.
  - Number and type of analytes; all required analytes were analyzed for in all progress samples.
  - Laboratory analysis procedures, data QA/QC procedures and criteria.

5.2.1.2 Post-dredge Sediment Surface Quality

A total of 67 sediment samples were collected from the post-dredge surface in SMAs 1–9, at locations shown in Figure 3.1, to evaluate compliance with SMS criteria. Two of these samples from the Northeast Shoreline were submitted for bioassay testing and evaluated for compliance using SMS biological criteria. One of the bioassay locations did not pass the SMS biological criteria; this area has been addressed by placement of a permanent sediment cap (as discussed in Section 3.4.3, Section 5.2.2.2, and Appendix D). The remaining 65 samples were compared to SQS chemical criteria to evaluate compliance. Analytical results for these samples are presented in Table 3.1.

Northern Portion of the Habitat Bench in Sediment Management Area 6

With the exception of one sample, collected from the northern portion of the habitat bench area within SMA 6, the overall chemistry of the post-dredge sediment surface within the TSSOU is very favorable (discussed below). Despite significant re-dredging of the bench area, sample TSP-06-08 collected from the northern end of the SMA 6 habitat bench, had SQS exceedances for several constituents, including copper, lead, mercury, zinc, LPAHs, and HPAHs.

In consultation with USEPA it was determined that in lieu of conducting additional dredging a minimum 2-foot-thick sand cover would be placed over the entire bench area prior to placing a 3-foot-deep layer of Type 2 Habitat Mix. The logic and rationale supporting this decision are summarized as follows:

- Initial dredging and follow-on re-dredging of the bench was accomplished using an environmental dredge bucket with dredging extending into native sediments.
- Core-logs indicated that sediment materials exceeding cleanup criteria consisted of a thin veneer (less than 4 inches thick) of re-distributed sediments.
- The area of the zone represented by sample TSP-06-08 is very small (~7,500 square feet). This area represents only 0.6 percent of the total open-water area (26.9 acres) dredged within the TSSOU. This area represents a very small percentage (0.5 percent) of the total remediation area (approximately 32 acres) at the TSSOU, and therefore poses little risk to the environment.
- Chemical exceedances in sample TSP-06-08 were generally below the CSL, except for a minor exceedance of the CSL for copper (SQS and CSL are the same for copper) and a significant exceedance for lead.

Remainder of TSSOU

Out of 569 chemical analytical results (from 64 samples collected from SMAs 1–9, excluding sample TSP-06-08), 12 samples exceeded the SQS for mercury alone, one sample exceeded the SQS for LPAHs alone, and one sample exceeded the SQS for mercury and LPAHs (refer to Table 3.1). In summary, 97.4 percent of the sample analytical results are less than the SQS chemical criteria.

The concentrations of mercury exceeding SQS criteria (0.41 mg/kg) in these samples ranged from 0.43 to 1.56 mg/kg. Except for the single result of 1.56 mg/kg, all mercury SQS exceedances are less than the Confirmational Number for the West Waterway (1.34 mg/kg), as stated in the 2003 ESD (USEPA 2003a). Likewise, the concentration of LPAHs exceeding the SQS criteria (370 mg/kg - OC Normalized or 5,200 µg/kg - Dry Weight) in these samples ranged from 598 mg/kg - OC Normalized to 9,219 µg/kg - Dry Weight, all less than the Confirmational Number for the West Waterway (780 mg/kg - OC Normalized or 13,000 µg/kg - Dry Weight).

The combined database of TSSOU chemical compliance results, excluding those from TSP-06-08, was evaluated statistically to assess compliance with cleanup criteria using USEPA guidance for statistical evaluation of confirmational sample results (USEPA 1989). The results of this statistical evaluation, presented in Table 5.1, indicate that the average (mean) concentration and the upper 95 percent confidence level on the mean concentration for all COCs are less than SQS chemical criteria for all analytes. Based on this statistical evaluation, Todd and USEPA have concluded that the post-dredge surface in all these areas of the Site meets cleanup criteria.

5.2.2 Capping

Sediment caps have been constructed in under-pier areas and in an open-water area along the Northeast Shoreline in SMA 2, as described in Section 4.0. The status of these capped areas is discussed in the following sections.

5.2.2.1 Under-pier Capping

Under-pier Cap Areas

Remedial action objectives were met in under-pier areas by placing cap material in accordance with the construction quality assurance procedures presented in the RAWP (FSM 2004). Details and documentation of construction quality assurance efforts for the under-pier capping are provided in Section 4.0. In summary, sand caps were placed under Piers 1A, 1, 2P, 3, 6, and 6P and within the over-water areas of the building berth to an average thickness of 1 foot and under Piers 4N and 5 to an average thickness of 3 feet. In all cases the caps extend beyond the pier footprints to include the "no dredge zone" areas immediately adjacent to the piers. Additionally, a 4-inch thick shotcrete cap was applied to the large consolidated debris mound under the Pier 6P in order to contain and limit exposure and access to the materials.

Contaminated sediments under the piers and within the over-water areas of the building berth will be fully remediated, after demolition, when the existing structures reach the end of their serviceable life.

Under-pier Cap—Pier 6P

In the RAWP and Final Design Report for the TSSOU, an area far back under Pier 6P was assumed to be impossible to cap. A best effort approach for placement of sand cap material in the area was proposed, using the throwing conveyor from all sides, following which an evaluation of the extent of the remaining uncapped area would be performed. During remedial action construction, more cap material was placed beneath Pier 6P than originally anticipated. Additionally, by using the throwing conveyor, the capping effort was successful in placing cap material further underneath the platform area than originally predicted. Diver surveys confirmed that cap material was successfully placed beneath approximately 75 percent of the Pier 6P area.

A small area remains uncapped, in shallow water just off-shore of the shotcrete capped area. This area is very far back in the recesses of Pier 6P; an area that is also filled with very densely spaced piling. The uncapped area is approximately 40 feet wide by 90 feet long. Todd and USEPA agreed that the remedial action in this area is considered complete, based on the following justification:

- The area beneath Pier 6P that was unable to be capped is very small. The uncapped area (3,600 square feet) represents only 1.6 percent of the total under-pier area to be capped (223,500 square feet) in the TSSOU. This area represents a very small percentage (0.2 percent) of the total remediation area (approximately 32 acres) at the TSSOU, and therefore poses little risk to the environment.

- The uncapped area is in a densely shaded setting, located very far back under Pier 6P, not adjacent to any face of the pier. Even if capped, this area would provide very poor aquatic habitat.
- The zone that was not capped beneath Pier 6P poses little risk of recontamination to adjacent areas because it has been scoured for decades and the substrate is therefore likely not loose or subject to movement.
- The under-pier cap at the Pier 6P provides a temporary remedial solution. This area will be dredged and permanently remediated once the platform and adjacent pier reach the end of their serviceable life and are demolished. Pier 6 is a wooden structure, which will be one of the first of the remaining piers at Todd to reach the end of its serviceable life and require demolition.

5.2.2.2 Sediment Management Area 2 Northeast Shoreline East Area Sediment Cap

Following the maximum extent of shoreline dredging in SMA 2, progress samples of the post-dredge sediment surface indicated that contamination greater than cleanup criteria remained. Additional characterization was conducted on the post-dredge surface, including bioassay analysis, to delineate the area that would require permanent capping. That supplemental characterization of the post-dredge surface in SMA 2 indicated that the 0.34-acre East Area required permanent capping to isolate contaminants that could not be removed through dredging.

As described in Appendix D, the shoreline fill section placed in SMA 2 was implemented to meet the requirements for a permanent cap. The shoreline fill section will both isolate underlying sediments in perpetuity, and attenuate dissolved contamination such that cleanup criteria is met at the cap surface. Geotechnical design of the shoreline fill at the TSSOU confirms that the fill has been constructed in a manner that will maintain permanent physical stability and isolation given the hydrodynamic forces at the Site. Comparison of the supplemental shoreline characterization data to the data used in the LSSOU sediment cap design contaminant transport modeling confirms that the sediment cap has been constructed to adequately provide chemical containment of contaminants exceeding the TSSOU cleanup criteria.

In the final Operations and Maintenance plan for the Site, Todd will commit to implementation of institutional controls and maintenance of the riprap surface to ensure that the fill area remains in place and is not eroded or otherwise disturbed.

5.2.3 In-water Filling

In-water filling was completed in five general areas of the TSSOU:

- Northeast Shoreline (SMAs 1 and 2)
- Buttress fill slope between Pier 4N and Pier 6 (SMAs 3 and 4)
- Buttress fill slope, habitat bench, and slope armoring in SMA 6
- Subtidal depression areas (SMAs 3, 5, and 7)
- Along isolated portions of the TSSOU boundary (SMAs 1, 5, 7, and 9)

This work and documentation of the related construction quality assurance efforts (provided in Section 4.0) demonstrate that all in-water filling activities were performed following the construction quality assurance procedures presented in the RAWP (FSM 2004).

5.3 INSTITUTIONAL CONTROLS

Institutional controls will be implemented at TSSOU to prohibit activities that would disturb the capped areas, including the Northeast Shoreline Sediment Cap, the under-pier capped areas, and the Western Shoreline Habitat Bench and to ensure that these areas are maintained over their lifetime. The areas of the Site where institutional controls are applicable are illustrated on Figure 5.1. Survey benchmarks for the Site are shown on Figure 5.2, which has been stamped by David Evans and Associates, Inc.

5.3.1 Northeast Shoreline Sediment Cap

The sediment cap in the Northeast Shoreline Area covers 0.34-acres. Todd has created a process memorandum describing the institutional controls for this sediment cap area, which describes how this area will be monitored and maintained over time. The institutional control process memo is included as an appendix in the TSSOU Operations, Maintenance and Monitoring Plan (OMMP; Floyd|Snider 2007). Todd's process memorandums define the procedures and restrictions that must be met for all operations throughout the Shipyard. The process memorandums are very tightly controlled, and are posted on Todd's intranet. Approval to remove or modify the Northeast Shoreline Sediment Cap Institutional Controls process memorandum is limited to Todd's Chief Counsel (the position currently held by Mike Marsh).

Todd will maintain the Northeast Shoreline Sediment Cap area in perpetuity, unless approval is received from both USEPA and Todd's Chief Counsel to cease maintenance. Long-term periodic monitoring will be required for this area to ensure that the slope is stable and riprap remains in place. Response actions are required if long-term performance standards are not being met, as summarized in Section 6.0. In addition, Todd will not excavate or dredge within this area without USEPA approval and appropriate planning.

5.3.2 Western Shoreline Habitat Bench

The habitat bench along the western shoreline covers 0.47-acres. Similar to the Northeast Shoreline Sediment Cap area, Todd has created a process memorandum describing the institutional controls for the Western Shoreline Habitat Bench, which describes how this area will be monitored and maintained over time. This process memorandum is included in the TSSOU OMMP. Approval to remove or modify the Western Shoreline Habitat Bench Institutional Controls process memorandum from Todd's intranet is limited to Todd's Chief Counsel (the position currently held by Mike Marsh).

The shoreline habitat bench is not a CERCLA required element of the project. It was constructed to provide habitat restoration that could be utilized in a future Natural Resource Damage (NRD) Settlement with the NRD Trustees. Todd intends to maintain this area in perpetuity, and to perform long-term periodic monitoring to ensure continued presence of habitat mix materials. Response actions will be implemented if long-term performance standards are not being met, as summarized in Section 6.0. These commitments will be confirmed with the NRD Trustees as part of future settlement negotiations.

5.3.3 Under-Pier Capped Areas

Under-pier capped areas include Piers 1A, 1, 2P, 3, 4N, 5, 6, and 6P and within the over-water areas of the building berth. An institutional control process memorandum for the under-pier capped areas has also been created by Todd. This process memorandum is included in the TSSOU OMMP. The memorandum describes how these under-pier capped areas will be monitored and maintained over time and also describes Todd's obligation to remove contamination located in an under-pier area when Todd removes or replaces a pier at the end of the pier's service life. Approval to remove or modify the Under-pier Sediment Caps Institutional Controls process memorandum from Todd's intranet is limited to Todd's Chief Counsel (the position currently held by Mike Marsh).

While the piers are in use, long-term erosion monitoring surveys will occur beneath the piers to ensure the caps remain in place, and contingency actions will be implemented in the event that there is evidence of significant cap erosion (refer to Section 6.0). To prevent or minimize erosion of the under-pier caps, BMPs are being and will continue to be implemented requiring ships operating adjacent to the piers to restrict engine power to minimum levels and for tugs not to operate such that prop wash is directed toward the caps.

When the existing pier structures reach the end of their serviceable capacity and are demolished, under-pier sediment will be dredged for permanent cleanup. If a pier structure is condemned for use by heavy industrial vehicular traffic, such as fire truck access, the pier structure will be demolished and cleanup will be triggered. When a pier is condemned, demolition and cleanup will begin within one year following condemnation and will be completed within three years following condemnation.

5.4 CONCLUSIONS ABOUT THE ADEQUANCY OF THE COMPLETED REMEDIAL ACTION AND STATUS OF THE REMEDIAL ACTION

All of the remedial action construction objectives stated in the ROD and Remedial Action SOW have been achieved for all portions of the TSSOU. All remedial action construction activities have been completed in accordance with the QAPP and verified according to the monitoring requirements of the RAWP and QAPP. USEPA performed an Interim Construction Inspection of the Site following completion of the first season of in-water work (in March 2005) and agreed that all areas of SMAs 1–5 met the Remedial Action Objective and project cleanup criteria. Similarly, an Interim Construction Inspection meeting was held on February 23, 2006 following completion of the second season of in-water work and USEPA agreed that all remaining areas (e.g., SMAs 6-9) met the Remedial Action Objective and project cleanup criteria. A Final Construction Inspection Meeting for the Site was completed by USEPA on July 11, 2007, following the 2006-2007 replacement structure construction work. Based on that meeting, USEPA has certified that the remedial action is complete, and no further action is anticipated.

The following certification is provided, as required by the Remedial Action in the SOW:

> "To the best of my knowledge, after thorough investigation, I certify under penalty of perjury that the information contained in or accompanying this submission is true,

accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Kate Snider, P.E.	Mike Marsh
Principal, Floyd|Snider	Chief Counsel, Todd Pacific Shipyard
Project Manager and Engineer of Record	Settling Defendant's Project Coordinator

6.0 Operation, Maintenance, and Monitoring Activities

Post-remedial action maintenance and monitoring activities will be performed at the TSSOU to verify the continued long-term effectiveness of the remedy in protecting human health and the environment, as required by the Remedial Action and Long-term Monitoring SOW (USEPA 2003c).

The requirements and specifications for long-term, post-construction maintenance and monitoring activities are presented in the TSSOU OMMP (Floyd|Snider 2007). These long-term maintenance and monitoring activities include the following:

- Physical integrity monitoring of under-pier caps, with contingencies for maintenance of the cap materials and potential sampling for COCs in areas adjacent to the piers if erosion of cap material has occurred.
- Physical integrity monitoring of the riprap along the Northeast Shoreline in SMA 2 to ensure stability of the sediment cap, with contingencies for maintenance of the cap if erosion of cap material has occurred.
- Physical integrity monitoring of the habitat mix along the Western Shoreline in SMA 6 to ensure the stability of the habitat bench, with contingencies for maintenance of the habitat mix substrate if erosion of this material has occurred.
- Stormwater source control monitoring through documentation of NPDES permit compliance and monitoring of potential stormwater conveyance system overflows for both NPDES and sediment COCs.
- Monitoring of dry dock AGB management source control actions through documentation of NPDES permit compliance.

The OMMP also describes supplemental monitoring activities that will be performed in the event of a large earthquake or severe storm. In addition, the OMMP describes potential response actions that may be implemented if monitoring results indicate that the remedy is not meeting the long-term performance standards.

The OMMP monitoring schedule begins with a baseline survey conducted in 2007 and is anticipated to be completed after 10 years following the baseline survey. Three monitoring events will occur during Year 1, Year 2, and Year 4 following completion of the baseline survey. If cap materials are stable after these three monitoring events, then an erosion monitoring survey will be conducted again after 6 years (at Year 10) following completion of the baseline survey (scheduled for 2017). If the results from the Year 10 monitoring event indicate cap material or habitat mix in the habitat bench continues to remain in place, long-term monitoring will be considered complete and no further routine monitoring will occur. However, if significant erosion is noted during any of the long-term monitoring events, contingency actions and an adjusted monitoring schedule will be implemented as described in the OMMP. Additional monitoring surveys will occur after ten years following a large earthquake or severe storm as defined in the OMMP.

7.0 Summary of Project Costs

The total cost of the completed TSSOU cleanup action was approximately 21 million dollars. This cost includes all direct and indirect costs of cleanup construction; including sediment disposal, demolition of Pier 2, Pier 4S, and the side-launch shipways, construction management, agency oversight, and quality assurance (QA) costs. Construction costs related to replacement over-water structures (North Trestle, Ship-launch Trestle, Pier 5/6 Fendering, etc.) are not included. Table 7.1 provides a summary breakdown of actual costs by category. Estimated costs for long-term monitoring of the remedial action are $350,000. These estimated costs include the baseline monitoring survey, four long-term monitoring surveys, and two supplemental monitoring surveys (one for an earthquake and one for a severe storm), as discussed in Section 6.0.

The cost of the selected remedial action in the ROD for Todd Shipyard was estimated by USEPA in 1996 at 4.5 to 6.9 million dollars. The remedial action described in the ROD and estimated in 1996 consisted of dredging shipyard sediments that exceeded the CSL and placing a minimum 2 foot cap of clean sediment to contain any remaining contamination. The costs for the remedial action did not include remediation of under-pier sediments. Cap monitoring and maintenance for this remedial action over a 10 year period following construction was estimated in 1996 to cost 1 million dollars. No further breakdown of the cap monitoring and maintenance costs was provided in the ROD.

The primary reasons for the difference between the actual cost of the TSSOU cleanup and the cost estimate in the 1996 ROD include:

- A change in the selected remedy over time, through the two ESDs and the requirements outlined in the SOW for the remedial action (USEPA 1999, 2003a, 2003c). The final remedy constructed included dredging of all contaminated sediments and shipyard waste in the open water areas to the lower SMS standard for permanent removal and also included capping of the under-pier sediments. Actual dredging and disposal costs were 14.4 million dollars, while the ROD estimated dredging and disposal costs at 4.6 million dollars. ROD capping costs of approximately 500,000 dollars only considered a sand cap in the open water areas, no riprap or habitat mix was included in this cost and the under-pier areas were not addressed. The actual capping and filling costs were around 2.6 million dollars.

- The ROD did not include costs for demolition of shipyard structures (approximately 1.1 million dollars).

- The ROD cost estimate was calculated in 1996 and implementation of the remedial action occurred between 2004 and 2007.

Table 7.1 provides a comparison of the actual costs summarized post-construction and the engineers estimate completed at the time of the final design. Overall, the actual costs and the engineers estimate differed by less than 1 million dollars. Actual costs that were significantly lower than the estimated costs included demolition of the side launch shipways, placement of the shotcrete cap on the debris mound below Pier 6P, placement of the sand at the TSSOU boundary, surveys, and construction management. Estimated Pier 4S debris mound excavation costs ended up being included in the actual costs for dredging. Actual costs that exceeded the estimated costs significantly included placement of the habitat mix and riprap.

8.0 Observations and Lessons Learned

By all measures the Todd Sediment Remediation Project was a success. The two most significant achievements of this project are that the work met USEPA performance standards and that remedial action construction was accomplished without significant impact to the operations and financial viability of the shipyard.

Listed below are site-specific observations and lessons learned:

- The primary key to success for a complex project such as this one, including the significant scheduling challenges associated with conducting the work within an operating shipyard, was to form a strong team and relationship between the Owner, the Contractor, and the Engineer. The Cost Plus Incentive Fee form of contract used to administer the project work motivated team members to complete every aspect of the construction in accordance with defined quality objectives at the lowest overall cost.
- Communicating frequently and openly with USEPA, and other regulatory agencies, and following through on promises made helped gain the trust of these agencies. In turn the regulatory agencies were very fair and helpful throughout the course of the project.
- The dredge equipment and approach utilized were crucial to the success of the dredging component of the project. The dredging equipment spread included: a large barge-mounted derrick crane capable of handling large clamshell dredge buckets, a computer and GPS controlled dredge positioning system with 20-centimeter horizontal accuracy, a large (24 cubic yards) closed and vented environmental dredge bucket, an inclined flat-decked drain barge, and two hopper barges. Given this equipment two key factors allowed the dredging to be completed successfully:
  1. The difference in stiffness between the soft, recently deposited, contaminated sediment versus the underlying stiff, uncontaminated, native sediment combined with the light weight environmental dredge bucket that was not capable of easily cutting into the stiff native sediments resulted in dredge cuts that predictably terminated at the interface between the contaminated and uncontaminated sediment. This combination of equipment and geology allowed the dredge operator to selectively remove overlying contaminated sediments while minimizing the quantity of uncontaminated sediment that was removed.
  2. The large bucket footprint of the 24-cubic-yard Cable Arm environmental dredge bucket (24 feet by 21 feet) minimized the number of cycles required to dredge a given plan area, thereby significantly minimizing redistribution of contaminated sediments.
- The dredge was initially outfitted with electronic equipment (boom angle indicator and pulse generator/line counter) to allow accurate and real-time tracking of the dredge bucket's actual elevation (Z). Although significant effort was expended this equipment was never found to be consistently accurate, likely because of hysteriesis and cable stretching problems, and its' use was discontinued. Accurate painting of the dredge bucket holding wire combined with use of an electronic tide gauge

allowed sufficiently accurate (±6 inches) determination of the dredge bucket's actual elevation.

- Having a nearby transload facility with the ability to quickly off-load hopper barges and a transportation system and internal storage capacity that allowed the transload facility to take as much material as the dredge operation could generate was very important. Because a potential breakdown of the barge off-loading operation could immediately impact the availability of hopper barges (used to receive dredged sediment) it was crucial to keep the off-loading operation up and running. Throughout the project the dredge was never unable to dredge because of a breakdown of the off-loading operation.

- Water quality monitoring performed during the initial stages of project demolition, dredging, and in-water filling work documented that the BMPs specified for these activities were successful in maintaining water quality within regulatory limits.

- Habitat mix (consisting of 1-1/2 inches minus sandy gravel) was placed over riprap at elevations above –10 feet MLLW with the goal of filling interstitial spaces within the riprap, thereby eliminating hiding places for organisms that may prey on juvenile salmon. Visual observations indicate that within a very short time period much of this material was washed away from the steep slope areas (e.g., 2H:1V or steeper) and redeposited down slope to flatter sloped areas (e.g., 5H:1V and flatter). However, habitat mix materials remained within the deepest interstitial spaces since these spaces are protected from wave action. Therefore, materials remaining in these deep interstial spaces should continue to minimize possible juvenile salmon prey hiding places.

- Flexibility to change the design or construction approach, as necessary to meet changing field/project conditions, was important in meeting performance standards and keeping the project on schedule. Examples of the important changes made during the course of the project include:

  * Development of and implementation of "Dredge Method 2" procedures once the dredge operator's ability to differentiate contaminated and uncontaminated sediment was confirmed.

  * Use of diver surveys to conduct QA checks on under-pier capping once planned QA procedures were determined to be unworkable.

  * Complete extraction of piling beneath Pier 4S, instead of pile cutoff at dredge depths as initially planned. Todd's decision not to fully rebuild Pier 4S allowed revision of the design criteria for this area thereby allowing piles to be fully extracted. This in turn significantly improved the ability to dredge this area to clean sediments.

  * The grain-size distribution of the habitat mix materials to be placed on the SMA 6 habitat bench was revised after learning of the hydrodynamic modeling performed for similar habitat work at the nearby Lockheed site.

9.0 Operable Unit Contact Information

This section provides information on the personal involved in the oversight, design, and construction of the TSSOU remedy.

Todd Shipyards Project Coordinator

Mike Marsh
Chief Counsel
Todd Pacific Shipyards Corporation
P.O. Box 3806
Seattle WA 98124
(206) 623-1635 x207
Michael.marsh@toddpacific.com

USEPA Project Manager

Lynda Priddy
1200 Sixth Avenue
Mail Stop: ECL-113
Seattle, WA 98101
(206) 553-1987
priddy.lynda@epa.gov

Floyd|Snider Project Manager and Engineer of Record

Kate Snider, P.E.
Two Union Square
601 Union Street, Ste 600
Seattle, WA 98101
(206) 292-2078
kate.snider@floydsnider.com

Floyd|Snider Project Engineer and Construction Manager

Stephen Reimers, P.E.
Two Union Square
601 Union Street, Ste 600
Seattle, WA 98101
(206) 292-2078
steve.reimers@floydsnider.com

General Construction Company Project Manager

Tom Coultas
19472 Powder Hill Place
Poulsbo, WA 98370
(360) 779-3200
tom.coultas@kiewit.com

10.0 References

Coast and Harbor Engineering (Coast and Harbor). 2005. Technical Memorandum Todd Shipyard Sediment Operable Unit Superfund Cleanup Project. 9 September.

Floyd|Snider. 2007. *Final Operation, Maintenance, and Monitoring Plan, Todd Shipyards Sediment Operable Unit.* 27 July.

Floyd|Snider. 2006. *Status re: final infrastructure construction, permitting, and BOs.* 6 October.

Floyd Snider McCarthy, Inc. (FSM). 2002. *Chemical, Biological, and AGB Testing Summary Todd Shipyards Sediment Operable Unit.* Seattle, Washington. 28 February.

_____. 2004. *Final Remedial Action Work Plan, Todd Shipyards Sediment Operable Unit.* 20 May.

FSM Team. 2004. *Final Design Report, Todd Shipyards Sediment Operable Unit.* 15 January.

United States Environmental Protection Agency (USEPA). 1989. *Methods for Evaluating the Attainment of Cleanup Standards, Volume 1: Soils and Solid Media.* EPA 230/02-89-042. February.

_____. 1996. *Record of Decision. Declaration, Decision Summary, and Responsiveness Summary for the Shipyard Sediment Operable Unity, Harbor Island, Seattle, Washington.* Seattle, Washington. November.

_____. 1999. *Explanation of Significant Difference to the Harbor Island – Todd Shipyards Portion of the Shipyard, Sediments Operable Unit, Record of Decision Seattle, Washington.* December.

_____. 2000. *Administrative Order on Consent for Remedial Design Todd Shipyard Sediment Operable Unit.* Seattle, Washington. 26 April.

_____. 2003a. *Explanation of Significant Differences to the Harbor Island – Shipyard Sediment Operable Unit, Todd Shipyard Sediments, Seattle, Washington, Selected Remedial Action.* March.

_____. 2003b. *Consent Decree for Todd Shipyards Sediment Operable Unit Remedial Action.* Harbor Island Superfund Site, Seattle, Washington. April.

_____. 2003c. *Statement of Work, Remedial Action and Long-Term Monitoring, Todd Shipyard Sediment Operable Unit, Harbor Island Superfund Site, Seattle, Washington.* April.

Washington State Department of Ecology (Ecology). 1995. *Washington Administrative Code (WAC) Chapter 173-204, Washington State Sediment Management Standards.* 29 December.

Tables

Remedial Action Completion Report

Todd Shipyards
Sediment Operable Unit

Tables

FINAL

Table 2.1
Chemical, Biological, and AGB Testing Summary

	Surface Sediment Data								Subsurface Sediment Data					
Sediment Management Unit (SMU)	Sampling Event (a)	Surface Sampling Location(s)	Chemical SQS Exceedance (b)	Chemical CSL Exceedance (b)	Biological SQS Results	Biological CSL Results	AGB Predominant?	Comment	Sampling Event (a)	Subsurface Sampling Location(s)	Thickness of layer Exceeding the SQS (ft) (b)	Thickness of Layer Exceeding the CSL or Containing AGB Predominance (ft) (b)	Comment	Depth Confirmation Data Available (c)
1a	Phase 2	TS-P2-01-S	None	None	NA	NA	YES	(d)	Phase 2	TS-P2-01-C	3 - (Hg, PCBs)	3 - (Hg)		All
1b	Phase 2	TS-P2-02-S	Hg, PCBs	Hg	PASS	PASS	NO		Phase 2	TS-P2-02-C	0.5 - (Hg, PCBs)	0.5 - (Hg)		All
1c	Phase 2	TS-P2-03-S	Hg, Zn	None	PASS (u)	PASS (u)	YES	(d)		None				
1d	Phase 2	TS-P2-04-S	Hg, PCBs, PAH	Hg	PASS	PASS	NO		Phase 2	TS-P2-04-C	3 - (PAH)	3 - (PAH)		All
2a		None								None				
2b	Phase 1A	TS-RD-S1	Cu, Hg, Zn, PCBs, PAH	Cu, Hg	PASS	PASS	NO		Phase 1A	TS-RD-C1	3 - (Hg)	3 - (Hg)	(e)	Hg
	Phase 1A	TS-RD-S24	As, Cu, Hg, Zn, PCBs, PAH	As, Cu, Hg, Zn	PASS	PASS	YES							
	Phase 1B	TS-049	As, Cu, Zn, PCBs, PAH	Cu, Zn	NA	NA	YES		Phase 1B	TS-049	>9 - (Hg, PAH)	>9 - (Hg)	(h)	All
	Phase 2	TS-P2-05-S	Cu, Zn	Cu, Zn	NA	NA	YES	(f,i)	Phase 2	TS-P2-05-C	4 - (Cu, Hg, Zn)	4 - (AGB, Cu, Hg, Zn)	(g)	All
	Phase 2	TS-P2-05B-S	Cu, Zn	Cu, Zn	NA	NA	YES	(i)						
		None							Phase 2	TS-P2-03-C	6 - (Hg)	6 - (Hg)	(e)	All
	Phase 2	GS-01					YES							
	Phase 2	GS-02					YES							
2c	Phase 1A	TS-RD-S25	As, Cu, Pb, Hg, Zn, PCBs, PAH	As, Cu, Pb, Hg, Zn, PCBs	FAIL	FAIL	NO		Phase 1B	TS-035	5 - (Hg)	2 - (Hg)	(e)	Hg
	Phase 2	GS-04					NO							
2d	Phase 2	TS-P2-06-S	Hg, Zn, PCBs, PAH	Hg, PAH	FAIL	PASS	NO		Phase 2	TS-P2-06-C	5 - (Hg)	5 - (Hg)	(e)	All
									Phase 1B	TS-048	6 - (Hg, PCBs)	0	(j)	All
2e	Phase 1A	TS-RD-S2	Cu, Hg, Zn, PCBs, PAH	Cu, Hg	PASS	PASS	NO		Phase 1A	TS-RD-C2	3 - (Hg)	3 - (Hg)	(e)	Hg
	Phase 1A	TS-RD-S26	Hg, PCBs, PAH	PAH	PASS	PASS	NO							
	TBT Study	TBT-33	(k)	(k)	NA	NA	NE							
	Phase 2	GS-05					NO							
2f	Phase 1A	TS-RD-S6	Hg, PCBs	None	FAIL	PASS	NO			None				
2g		None							Phase 2	TS-P2-07-C	14 - (Hg)	14 - (Hg)	(e)	All
3a	Phase 1A	TS-RD-S3	As, Cu, Zn, PCBs, PAH	As, Cu, Zn, PAH	FAIL	FAIL	YES			None				
3b	Phase 2	TS-P2-09B-S	PCBs, PAH	None	NA	NA	NO			None				
3c	Phase 1A	TS-RD-S7	Cu, Hg, Zn, PCBs, PAH	Cu, Hg	FAIL	PASS	NO		Phase 1A	TS-RD-C7	3 - (Hg)	3 - (Hg)	(e)	Hg
	Phase 2	GS-08					NO							
3d	Phase 1A	TS-RD-S4	As, Cu, Hg Zn, PCBs, PAH	As, Cu, Hg, Zn, PAH	FAIL	FAIL	YES		Phase 1A	TS-RD-C4	3 - (As, Cu, Hg, Zn, PCBs, PAH)	3 - (As, Cu, Hg, Zn, PAH)		All
	Phase 1A	TS-RD-S8	Cu, Hg, Zn, PCBs, PAH	Cu, Hg	FAIL	FAIL	NO		Phase 1A	TS-RD-C8	5.3 - (Hg)	5.3 - (Hg)	(e)	Hg
	TBT Study	TBT-31	(k)	(k)	NA	NA	NE		Phase 1B	TS-034	3 - (Hg)	3 - (Hg)	(e,l)	Hg
									Phase 2	TS-P2-10-C	10 - (PAH)	10 - (PAH)	(m)	All
	Phase 2	GS-06					NO							

Table 2.1
Chemical, Biological, and AGB Testing Summary

	Surface Sediment Data								Subsurface Sediment Data					
Sediment Management Unit (SMU)	Sampling Event (a)	Surface Sampling Location(s)	Chemical SQS Exceedance (b)	Chemical CSL Exceedance (b)	Biological SQS Results	Biological CSL Results	AGB Predominant?	Comment	Sampling Event (a)	Subsurface Sampling Location(s)	Thickness of layer Exceeding the SQS (ft) (b)	Thickness of Layer Exceeding the CSL or Containing AGB Predominance (ft) (b)	Comment	Depth Confirmation Data Available (c)
	Phase 2	GS-09					NO							
3e	SRI	HI-NS-14	Cu, Hg, Zn, PCBs, PAH	Cu, Hg, PCBs	FAIL	PASS	NE							
	Phase 1A	TS-RD-S5	As, Cu, Pb, Hg, Zn, PCBs, PAH	As, Cu, Pb, Hg, Zn, PCBs, PAH	FAIL	PASS	NO		Phase 1A	TS-RD-C5	1.8 - (Cu, Hg, Zn, PCBs, PAH)	1.8 - (Cu, Hg)		All
	Phase 1A	TS-RD-S10	As, Cu, Pb, Hg, Zn, PCBs, PAH	As, Cu, Pb, Hg, Zn, PCBs, PAH	PASS	PASS	YES							
	Phase 2	GS-07A					NO							
	Phase 2	GS-07B					NO							
	Phase 2	GS-10					NO							
3f	Phase 2	TS-P2-11-S	Hg, PCBs	Hg	FAIL	FAIL	NO		Phase 2	TS-P2-11-C	0.5 - (Hg, PCBs)	0.5 - (Hg)		All
3g	Phase 1A	TS-RD-S9	Cu, Hg, Zn, PCBs, PAH	Cu, Hg, PCBs, PAH	PASS	PASS	NO			None				
	TBT Study	TBT-32	(k)	(k)	NA	NA	NE							
	Phase 2	GS-11					NO							
3h	Phase 2	TS-P2-08-S	Cu, Hg, PCBs	Cu, Hg	FAIL	PASS	NO		Phase 2	TS-P2-08-C	0.5 - (Cu, Hg, PCBs)	0.5 - (Cu, Hg)		All
4a	Phase 1B	TS-033	Cu, Hg, Zn, PCBs, PAH	Cu, Hg, PAH	NA	NA	NO		Phase 1B	TS-033	0.5 - (Cu, Hg, Zn, PCBs, PAH)	0.5 - (Cu, Hg)	(n)	Hg
	Phase 2	TS-P2-12-S	Cu, Hg, Zn, PAH	Cu	FAIL	FAIL	NO							
	Phase 2	TS-P2-12X-S	Cu, Hg, Zn, PCBs, PAH	Cu, Hg	FAIL	FAIL	NO							
4b	Phase 1A	TS-RD-S27	Cu, Zn, PAH	Cu, Zn	FAIL	FAIL	YES		Phase 1A	TS-RD-C27	6 - (Hg)	6 - (Hg)		All
									Phase 2	TS-P2-13-C	>1.7 - (Hg)	>1.7 - (Hg)	(e,o)	All
		None/See comment					YES	(f)	Phase 2	TS-P2-15-C	1 - (Hg)	1 - (Hg)	(e)	All
4c	SRI	HI-NS-10	PCBs	None	PASS	PASS	NE		Phase 1A	TS-RD-C12	1.5 - (Hg, PCBs, PAH)	1.5 - (Hg)		All
	Phase 2	GS-16					NO							
4d	Phase 1A	TS-RD-S12	Cu, Hg, Zn, PCBs, PAH	Cu, Hg	FAIL	FAIL	NO			None				
4e	Phase 2	TS-P2-14-S	Cu, Hg	Cu, Hg	FAIL	FAIL	NO		Phase 2	TS-P2-14-C	0.4 - (Hg)	0	(e)	All
	SRI	HI-NS-09*	Cu, Hg, PAH, PCBs	Cu, Hg, PCBs	FAIL	PASS	NE			None				
4f	Phase 1A	TS-RD-S17	Hg, Zn, PCBs, PAH	Hg	PASS	PASS	NO			None				
4g	Phase 2	TS-P2-16-S	Cu, Zn, PCBs, PAH	Cu	FAIL	FAIL	NO			None				
4h*	SRI	HI-NS-09	Cu, Hg, PAH, PCBs	Cu, Hg, PCBs	FAIL	PASS	NE			None				
5a	Phase 2	TS-P2-21-S	Hg, PCBs	None	FAIL	FAIL	NO			None				
	TBT Study	TBT-29	(k)	(k)	NA	NA	NE							
5b	Phase 1B	TS-032	As, Cu, Hg, Zn, PCBs, PAH	Cu, Hg, Zn	FAIL	FAIL	NO		Phase 1B	TS-032	3.5 - (Hg)	3.5 - (Hg)	(e)	Hg
	Phase 2	GS-15					NO							
5c	Phase 1A	TS-RD-S16	As, Cu, Pb, Hg, Zn, PCBs, PAH	As, Cu, Pb, Hg, Zn	FAIL	PASS	NO		Phase 1A	TS-RD-C16	3 - (Hg)	3 - (Hg)	(e)	Hg
	Phase 2	GS-14					NO							

Table 2.1
Chemical, Biological, and AGB Testing Summary

	Surface Sediment Data								Subsurface Sediment Data					
Sediment Management Unit (SMU)	Sampling Event (a)	Surface Sampling Location(s)	Chemical SQS Exceedance (b)	Chemical CSL Exceedance (b)	Biological SQS Results	Biological CSL Results	AGB Predominant?	Comment	Sampling Event (a)	Subsurface Sampling Location(s)	Thickness of layer Exceeding the SQS (ft) (b)	Thickness of Layer Exceeding the CSL or Containing AGB Predominance (ft) (b)	Comment	Depth Confirmation Data Available (c)
	Phase 2	GS-20					NO							
5d	Phase 1A	TS-RD-S15	Hg, Zn, PCBs	Hg	PASS	PASS	NO		Phase 1A	TS-RD-C15	0.5 - (Hg)	0.5 - (Hg)	(e)	Hg
6a	Phase 2	TS-P2-19-S	Cu, Hg, Zn, PAH	Cu, Hg	FAIL	FAIL	NO		Phase 2	TS-P2-19-C	10.5 - (Hg, PAH)	10.5 - (Hg)	(e,p)	All
6b	Phase 1A	TS-RD-S19	As, Cu, Pb, Hg, Zn, PCBs, PAH	As, Cu, Hg, Zn, PCBs, PAH	FAIL	PASS	YES			None				
7a	Phase 1B	TS-031	As, Hg, Zn, PAH	Hg	FAIL	FAIL	NO		Phase 1B	TS-031	3 - (Hg)	3 - (Hg)	(e)	Hg
7a	Phase 2	GS-22					NO							
7b	Phase 1A	TS-RD-S20	As, Cu, Hg, Zn, PCBs, PAH	As, Cu, Hg, Zn, PCBs, PAH	PASS	PASS	NO		Phase 1A	TS-RD-C20	2.3 - (Hg)	2.3 - (Hg)	(e)	Hg
	TBT Study	TBT-26	(k)	(k)	NA	NA	NE							
	Phase 2	GS-13					NO							
7c	Phase 1A	TS-RD-S18	PCBs	None	PASS	PASS	NO		Phase 1A	TS-RD-C18	0.5 - (PCBs)	0		Hg
	Phase 2	GS-21					NO							
7d	Phase 2	TS-P2-20-S	None	None	NA	NA	NO							
	SRI	HI-WW-30	Hg	Hg	NA	NA	NE		SRI	HI-WW-30	1.6 - (Hg)	1.6 - (Hg)	(e)	Hg
	Phase 1B	TS-042	Hg, PCBs, PAH	Hg	NA	NA	NE		Phase 1B	TS-042	6 - (Hg)	6 - (Hg)		All
7e*	Phase 2	TS-PS-22-S	Hg, PCBs	Hg	PASS	PASS	NE		Phase 1B	TS-043	6 - (Hg)	6 - (Hg)		All
8a	Phase 1A	TS-RD-S23	As, Cu, Hg, Zn, PCBs, PAH	Cu	FAIL	PASS	NO		Phase 1A	TS-RD-C23	3 - (Hg)	3 - (Hg)	(e)	Hg
	TBT Study	TBT-034	(k)	(k)	NA	NA	NE							
	Phase 2	GS-29					NO							
8b	Phase 1B	TS-030	Cu, Hg, Zn, PCBs, PAH	Cu, Hg	FAIL	PASS	NO		Phase 1B	TS-030	2.1 - (Hg)	2.1 - (Hg)	(e)	Hg
	Phase 2	GS-12					NO							
	Phase 2	GS-23					NO							
	Phase 2	GS-24					NO							
8c	Phase 1B	TS-028	Hg, PAH	None	FAIL	PASS	NO		Phase 1B	TS-028	3 - (Hg)	3 - (Hg)	(e)	Hg
8d	Phase 1B	TS-029	Hg, PAH	None	PASS	PASS	NO		Phase 1B	TS-029	4.5 - (Hg, PCBs, PAH)	4.5 - (Hg, PCBs, PAH)	(q)	All
9a	SRI	HI-WW-23	Hg, Zn, PCBs, PAH	Hg, Zn	FAIL	PASS	NE							
	SRI	HI-WW-24	Hg, PCBs	None	PASS	PASS	NE							
	Phase 1B	TS-039	Hg, PCBs, PAH	None	NA	NA	NE		Phase 1B	TS-039	<3	<3	(r)	All
	Phase 2	TS-P2-17-S	Cu, Zn	Cu	NA	NA	YES	(i)	Phase 2	TS-P2-17-C	4.4 - (Hg)	2.9 - (AGB), 4.4 - (Hg)	(s)	All
	Phase 2	TS-P2-17B-S	Cu	Cu	NA	NA	YES	(i)						
	Phase 2	GS-30					NO							
9b	Phase 2	TS-P2-18-S	PCBs	None	PASS	PASS	YES	(d)						
	Phase 1B	TS-040	Hg, Zn, PCBs, PAH	Hg	NA	NA	NE		Phase 1B	TS-040	<3	<3	(t)	All

Table 2.1
Chemical, Biological, and AGB Testing Summary

	Surface Sediment Data								Subsurface Sediment Data					
Sediment Management Unit (SMU)	Sampling Event (a)	Surface Sampling Location(s)	Chemical SQS Exceedance (b)	Chemical CSL Exceedance (b)	Biological SQS Results	Biological CSL Results	AGB Predominant?	Comment	Sampling Event (a)	Subsurface Sampling Location(s)	Thickness of layer Exceeding the SQS (ft) (b)	Thickness of Layer Exceeding the CSL or Containing AGB Predominance (ft) (b)	Comment	Depth Confirmation Data Available (c)
	SRI	HI-WW-26	Cu, Hg, PCBs, PAH	Cu, Hg	NA	NA	NE							
	Phase 2	GS-27					NO							
	Phase 2	GS-28					NO							
9c	Phase 1A	TS-RD-S21	Hg	Hg	PASS	PASS	NO		Phase 1A	TS-RD-C21	3 - (Hg)	3 - (Hg)	(e)	Hg
	Phase 1A	TS-RD-S22	Hg, Zn, PCBs, PAH	None	PASS	PASS	NO		Phase 1A	TS-RD-C22	0.5 - (Hg)	0	(e)	Hg
	Phase 1B	TS-041	Hg, PCBs, PAH	None	NA	NA	NE		Phase 1B	TS-041	>9 - (Hg)	>9 - (Hg)	(h)	All
	Phase 2	GS-25					NO							
	Phase 2	GS-26					NO							

Notes:

(a) SRI: Supplemental Remedial Investigation, samples collected in 1995 (EVS 1996); Phase 1A: Remedial Design Sampling and Analysis, samples collected in 1997 (Landau 1999); TBT Study: samples collected in 1998 (EVS Consultants 1999); Phase 1B: Remedial Design Sampling and Analysis, samples collected in 1999 (Landau 2000, Roy F. Weston 1999); Phase 2:Remedial Design Sampling and Analysis, samples collected in 2001 (Landau 2001).

(b) The constituents listed exceeded the stated criteria; criteria for PCBs and PAHs are based on organic carbon normalized concentrations (mg/kg-OC).

(c) All = Indicates all ROD constituents underwent testing in the interval used to confirm the thickness of the contaminated layer. The interval used to confirm the thickness was the next deepest interval below the contaminated layer.
Hg = Indicates only mercury concentrations were used as a surrogate to confirm the thickness of the contaminated layer.

(d) The location that contains AGB at a level constituting a predominance was determined based on evaluation of discrete samples; please refer to the associated figure for the specific location where AGB is predominant.

(e) Hg only was tested for in the deepest contaminated interval.

(f) AGB at a level constituting a predominance is present in surface sediment at TS-P2-05-C and TS-P2-15-C.

(g) Chemical testing was only performed for Cu, Hg, Zn, and organotins in the 2 to 4 ft interval.

(h) Hg contamination extends to a depth of at least 9 ft below mudline; no sediment intervals were collected below this depth.

(i) Chemical testing was only performed for Cu, Zn, and organotins.

(j) Core data contained no CSL exceedances at a depth greater than 3 ft below mudline. The 0.5 to 3.0 ft interval was not analyzed.

(k) Surface sediment testing during the TBT study was limited to organotins.

(l) Core met with refusal at 3 ft; riprap present.

(m) The thickness indicated is a minimum; no sediment intervals were collected below this depth.

(n) Core met with refusal at 2 ft; riprap present.

(o) Contamination above the CSL is greater than 1.7 ft deep but less than 2.9 ft.

(p) A very low level exceedance of the SQS for acenaphthene extends to a depth of 12 ft at this location.

(q) As, Cu, Pb, and Zn were not analyzed for in the core intervals.

(r) Core data contained no SQS or CSL exceedances at a depth greater than 3 ft below mudline. The 0.5 to 3.0 ft interval was not analyzed.

(s) Cu, Hg, and Zn only were tested for in the 0-1.7 and 1.7-2.9 subsurface intervals. Hg only was tested for in the 2.9-4.4 subsurface interval.

(t) Core data contained no SQS or CSL exceedances at a depth greater than 3 ft below mudline. The 0.5 to 3.0 ft interval was not analyzed.

(u) Composite sample developed from locations A, B, and C. Note that location B is within SMU 2b.

PAH Polynuclear aromatic hydrocarbons

PCBs Polychlorinated biphenyls

NE Not evaluated

NA Biological testing was not performed because surface sediment concentrations were below SMS chemical criterion or toxicity information was not needed at that location.

* SMU was not listed in PDR Table 3.1 but has been subsequently added as a new SMU due to TSSOU boundary changes.

This table does not include Remedial Investigation data collected by Roy F. Weston for the USEPA.

Table 2.2
Surface Sediment Chemistry Data

SMA	Location	Sample ID	Sample Date	Upper Depth (cm)	Lower Depth (cm)	2002 Mudline Elevation (ft)	Arsenic (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Zinc (mg/kg)	TOC (%)	HPAHs (mg/kg OC)	LPAHs (mg/kg OC)	PCBs (mg/kg OC)	TBT (µg/kg)	TBT (mg/kg OC)
						SQS Chemical Criteria	57	390	450	0.41	410	NA	960	370	12	1335*	76**
						CSL Chemical Criteria	93	390	530	0.59	960	NA	5300	780	65		
1	TS-P2-01-S	TS-P2-01-S	2/20/2001	0	10	-35	23	205	84 J	0.4 J	278 J	1.8	334.44	48.22	11.06	462.8	25.71
1	TS-P2-02-S	TS-P2-02-S	2/20/2001	0	10	-38.5	11.4	112	55 J	0.72 J	121 J	1.2	377.5	64.75	28.33	231.4	19.28
1	TS-P2-03-S	TS-P2-03-S	2/21/2001	0	10	-30	54	349	157 J	0.5 J	537 J	1.4	587.14	88.5	11.36	881.1	62.94
1	TS-P2-04-S	TS-P2-04-S	2/22/2001	0	10	-34.8	17.1	232 J	114 J	1.8 J	223 J	1.6	723.75	108.38	30	685.3	42.83
1	TS-P2-04-S	TS-P2-XX-S	2/22/2001	0	10	-34.8	19.4	372 J	200 J	3.2 J	269 J	1.6	1475.62	116.25	26.88 J	685.3	42.83
2	TS-P2-05-S	TS-P2-05-S	2/22/2001	0	10	-34.3		1240			3420 J	1.4				20470 J	1462.14 J
2	TS-RD-S1	TS-RD-S1	10/13/1997	0	10	-40.2	46 J	543	139	1.22 J	457	2	1025.5 JM	127 J	20.4	4450 J	222.5 J
2	TS-P2-05B-S	TS-P2-05B-S	3/2/2001	0	10	-38.3		987			2410	0.86				1691	***
2	TS049	SD-TS049-0000	3/1/1999	0	10	-24.4	64	658	101 J	0.4	1220	1.36	854.41	109.63	24.63	1500 J	110.29 J
2	TS-RD-S24	TS-RD-S24	10/13/1997	0	9	-31.2	145 J	500	240	0.84 J	1220	1.6	716.88 J	170.62 J	14.44	1602 J	100.12 J
2	TS-RD-S25	TS-RD-S25	10/13/1997	0	10	-34.3	490 J	944	780	4.2 J	3340	2.1	920.48 JM	82.43 J	64.9	979 J	46.62 J
2	TS048	SD-TS048-0000	2/26/1999	0	10	-37.9	35 J	428	126 J	1.8	529	1.24	1045.16	108.06	67.98	1100 J	88.71 J
2	TS-P2-06-S	TS-P2-06-S	2/21/2001	0	10	-40	31 J	360	133 J	1.05 J	438 J	1.9	1777.37	107.68	23.68 J	1335	70.26
2	TS-P2-06-S	TS-P2-XX-S2	2/21/2001	0	10	-40	52 J	369	167 J	0.57 J	524 J	1.4	851.43	181.93	13.71 J	1246	89
2	TS-RD-S2	TS-RD-S2	10/13/1997	0	9	-41.3	39 J	698	138	0.95 J	555	1.4	1040.71 JM	136.64 J	26.86	1780 J	127.14 J
2	TS-RD-S26	TS-RD-S26	10/13/1997	0	10	-40	13.7 J	171	59	0.53 J	222	1.5	1799.33 J	131.2 J	13.33	1691 J	112.73 J
2	TS-RD-S6	TS-RD-S6	10/13/1997	0	10	-43	12.1 J	188	69	0.54 J	164	1.7	297.06 J	36.06 J	16	2225 J	130.88 J
3	TS-RD-S3	TS-RD-S3	10/8/1997	0	10	-16.7	187 J	1230	430	0.34 J	1620	2.4	4614.17 J	1716.25 J	16.96	4717 J	196.54 J
3	TS-P2-09B-S	TS-P2-09B-S	2/27/2001	0	10	-26.9	16	332	61 J	0.39 J	187 J	0.48	757.5	218.12	27.92	1691	***
3	TS-RD-S7	TS-RD-DS7	10/10/1997	0	10	-46	28	1180	174	2.5	575	2.5	814.4 JM	98.8 J	26.72	13350 J	534 J
3	TS-RD-S7	TS-RD-S7	10/10/1997	0	10	-46	27	957	163	3	543	2.5	959.2 JM	108.4 J	22.04	14240 J	569.6 J
3	TS-RD-S4	TS-RD-S4	10/10/1997	0	10	-34.7	109	3440	420	1.4	1960	2.3	3600 J	765.65 J	27.43	19580 J	851.3 J
3	TS-RD-S8	TS-RD-S8	10/10/1997	0	10	-49.7	44	1080	242	1.96	832	2.5	1173.6 J	131.2 J	50.96	14240 J	569.6 J
3	TS-RD-S5	TS-RD-S5	10/13/1997	0	10	-38	118 J	1490	630	4.8 J	1300	2.1	2480.95 J	386.19 J	113.14	10680 J	508.57 J
3	HI-NS-14	NS-14	3/22/1995	0	10	-49	40	303 J	799 J	0.02 U	1930 J	1.8	1488.89	158.33	76.11	13346.8	741.49
3	TS-RD-S10	TS-RD-S10	10/9/1997	0	10	-5.6	195 J	1480	1180	6.6 J	2950	1.3	2474.62 J	296.15 J	159.38	6052 J	465.54 J
3	TS-P2-11-S	TS-P2-11-S	2/21/2001	0	10	-44	12.8	268	48 J	1.46 J	203 J	1.5	290.13	50.27	22.67	1869	124.6
3	TS-RD-S9	TS-RD-S9	10/10/1997	0	10	-44.8	50	555	250	4.4	461	1.5	1602.67 JM	234.4 J	106.87	4272 J	284.8 J
3	TS-P2-08-S	TS-P2-08-S	2/21/2001	0	10	-37	14.4	1460	81 J	1.7 J	209 J	1.2	307.33	46.67	31.67	453.9	37.83
4	TS-033	TS033-0G-0000	3/15/1999	0	15.24	-35	28	1860	119 J	0.88	770	1.7	1990 J	844.47 JM	19.41	37380	2198.82
4	TS-P2-12-S	TS-P2-12-S	2/28/2001	0	10	-23.5	19	2310	75	0.45	777	1.8	1333.89	344.94	5.28	28480	1582.22
4	TS-P2-12X-S	TS-P2-12X-S	3/7/2001	0	10	-30.5	18	828	70	0.6	423	1.7	1438.82	159.41	18.82	9790	575.88
4	TS-RD-S27	TS-RD-S27	10/8/1997	0	10	-54	35 J	2300	450	0.24 J	1020	1.7	1181.18 J	295.29 J	3.06	36490 J	2146.47 J
4	HI-NS-10	NS-10	3/23/1995	0	10	-50.4	10.2	136	28	0.022	82.4 J	0.93	291.4 JM	45.59	23.66	2047.16	***
4	TS-RD-S12	TS-RD-S12	10/6/1997	0	10	-57	30 J	965	80	0.68 J	627	0.95	1924.21 J	297.47 J	23.89	8900 J	***
4	TS-P2-14-S	TS-P2-14-S	2/21/2001	0	10	-63	15.7	602	58 J	0.88 J	403 J	1.5	483.33	77.93	8.93	6052	403.47
4	TS-RD-S17	TS-RD-S17	10/9/1997	0	10	-40	26 J	368	147	1 J	486	0.8	1357.5 JM	230 J	31.62	5696 J	***
4	TS-P2-16-S	TS-P2-16-S	2/27/2001	0	10	-47.6	17	1520	95 J	0.28 J	910 J	0.87	1091.95	140.8	41.72	6942	***
4	HI-NS-09	NS-09	3/23/1995	0	10	-91	21.4	434	108	0.94	181 J	1	997 JM	186	100	7466.4	746.64
5	TS-P2-21-S	TS-P2-21-S	2/23/2001	0	10	-44	12.4	253	118 J	0.51 J	351 J	1.2	464.17	70	18	3916	326.33
5	TS-032	TS032-0G-0000	3/9/1999	0	15.24	-45.3	60	1050	249 J	0.91	1140	1.9	1616.84 J	278.74	63.68	17800	936.84
5	TS-RD-S16	TS-RD-S16	10/10/1997	0	10	-47.7	101	662	570	1.68	1450	1.7	1082.35 J	127.76 J	45.88	8010 J	471.18 J

Table 2.2
Surface Sediment Chemistry Data

SMA	Location	Sample ID	Sample Date	Upper Depth (cm)	Lower Depth (cm)	2002 Mudline Elevation (ft)	Arsenic (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Zinc (mg/kg)	TOC (%)	HPAHs (mg/kg OC)	LPAHs (mg/kg OC)	PCBs (mg/kg OC)	TBT (µg/kg)	TBT (mg/kg OC)
						SQS Chemical Criteria	**57**	**390**	**450**	**0.41**	**410**	**NA**	**960**	**370**	**12**	**1335***	**76****
						CSL Chemical Criteria	**93**	**390**	**530**	**0.59**	**960**	**NA**	**5300**	**780**	**65**		
5	TS-RD-S15	TS-RD-S15	10/10/1997	0	10	-41.6	35	327	104	**1.26**	**453**	1.1	419.45 J	90.64 J	**28.09**	1602 J	**145.64 J**
6	TS-P2-19-S	TS-P2-19-S	3/7/2001	0	10	-16.3	18	**409**	143	**0.66**	**413**	2.2	**991.36**	155.91	11.5	685.3	31.15
6	TS-RD-S19	TS-RD-S19	10/9/1997	0	10	-8.6	**210 J**	**895**	**480**	**2.2 J**	**2080**	1.8	**1506.67 JM**	204.67 J	**262.5**	1780 J	**98.89 J**
7	TS-031	TS031-0G-0000	3/16/1999	0	15.24	-36.7	**60**	346	146 J	**0.62**	**463**	1.9	**1652.11 J**	**525 JM**	10.37	16020	**843.16**
7	TS-RD-S20	TS-RD-S20	10/10/1997	0	10	-40.5	**140**	**1210**	410	**1.9**	**1310**	1.4	**1540 J**	250 J	**130.86**	1780 J	**127.14 J**
7	TS-RD-S18	TS-RD-S18	10/10/1997	0	10	-44.7	9.5	121	31	0.21	103	1.2	325.83 JM	45.25 J	**36.75**	3382 J	**281.83 J**
7	HI-WW-30	WW-30-HC	3/16/1995	0	10	-41.5	30	277	212	**4.6**	326	1.7	307.65	43.24	2.24	541.68 J	31.86 J
7	TS042	SD-TS042-0000	3/2/1999	0	10	-43	19	182	102 J	**1.3**	273	1.43	395.8	54.2	**41.61**	750 J	52.45 J
7	TS-P2-20-S	TS-P2-20-S	2/22/2001	0	10	-44	7.1	91.4	39 J	0.33 J	112 J	1.2	131.83	27	4.67	382.7	31.89
7	TS-P2-22-S	TS-P2-22-S	2/23/2001	0	10	-49.5	11	195	57 J	**1.05 J**	178 J	1.6	363.12	64.06	**17.69**	1691	**105.69**
7	TS043	SD-TS043-0000	3/2/1999	0	10	-49.1	12	173	82 J	**0.9**	166	1.16	476.72	66.38	**21.29**	1600 J	**137.93 J**
8	TS-RD-S23	TS-RD-S23	10/10/1997	0	10	-29.4	**69**	**838**	310	**0.5**	**645**	2	932.5 J	119.1 J	**19.4**	1424 J	71.2 J
8	TS-P2-17-S	TS-P2-17-S	2/22/2001	0	10	-7.6		**809**			**489 J**	2				275.9 J	13.79 J
8	TS-P2-17B-S	TS-P2-17B-S	3/2/2001	0	10	-9.7		**480**			327	1.9				453.9	23.89
8	TS-030	TS030-1G-0000	3/9/1999	0	15.24	-31.5	32	**748**	144 J	**0.6**	**486**	1.6	815.62 J	122.31	**15**	1602 J	**100.12 J**
8	TS-030	TS030-0G-0000	3/9/1999	0	15.24	-31.5	37	**660**	172 J	**0.66**	**489**	1.7	671.76 J	83.65	**16.47**	3382 J	**198.94 J**
8	TS-028	TS028-0G-0000	3/9/1999	0	15.24	-29	23	239	171 J	**0.46**	293	2	718 J	79.55 J	12	979	48.95
8	TS-029	TS029-0G-0000	3/15/1999	0	15.24	-25.2	29	309	146 J	**0.43**	326	2.6	**1066.54 J**	172.69 J	6.46	809.9	31.15
9	HI-WW-23	WW-23	3/21/1995	0	10	-30.4	29	209	194	**1.22 J**	**2280**	2.4	500 JM	79.88	**18.38**	1512.8	63.03
9	HI-WW-24	WW-24	3/21/1995	0	10	-40	21	89	88	0.008 U	**2010**	2.1	500 JM	81.29	**12.86**	1956.88	**93.18**
9	TS039	SD-TS039-0000	3/2/1999	0	10	-41	15	181	111 J	**0.5**	214	1.35	648.89	93.19	**31.93**	1100 J	**81.48 J**
9	HI-WW-26	WW-26	3/17/1995	0	10	-40.2	52	232	179	0.01 U	288	1.9	747.37 JM	130.47	**17.37**	2928 J	**154.11 J**
9	TS040	SD-TS040-0000	3/2/1999	0	10	-36.4	38	150	131 J	**0.9**	**438**	1.07	447.66	52.15	**26.92**	530 J	49.53 J
9	TS-P2-18-S	TS-P2-18-S	3/5/2001	0	10	-36.1	46	103	79	0.27	400	0.87	195.98	29.31	**17.7**	213.6	***
9	TS041	SD-TS041-0000	3/2/1999	0	10	-49.2	22	194	83 J	**0.5**	213	1.24	752.42	105.48	**25**	1300 J	**104.84 J**
9	TS-RD-S21	TS-RD-S21	10/10/1997	0	9	-40.2	52	127	145	**1.46**	274	1.4	430.71 JM	72.93 J	9.93	587.4 J	41.96 J
9	TS-RD-S22	TS-RD-DS22	10/10/1997	0	10	-41.3	39	318	147	0.41	**615**	1.7	462.06 J	50 J	**40**	1869 J	**109.94 J**
9	TS-RD-S22	TS-RD-S22	10/10/1997	0	10	-41.3	48	360	150	**0.53**	**628**	1.4	724.29 J	76.86 J	**18.57**	1958 J	**139.86 J**

Notes:
* Confirmational number for TBT (ug/kg) when TOC is less than 1%.
** Confirmational number for TBT (mg/kg-OC) when TOC is equal to or greater than 1%.
*** No TBT mg/kg-OC concentration calculated; TOC is less than 1%.
J The associated value is an estimate.
JM Indicates an analyte detected with low spectral match parameters and a value below calibration range or reporting limit and is estimated.
U Analyte was not detected at or above the level of the associated value.
NA Not available.
Bold values indicate exceedances of the Washington State Sediment Quality Standards (SQS).

Table 3.1
Final Progress Sampling Results

Analytes	Units	Compliance Criteria[2]	Sampling Locations[1]						
			SMA 1						
			TSP-01-01	TSP-01-02	TSP-01-03	TSP-01-04	TSP-01-05	TSP-01-06	TSP-01-07
			9/21/2004	9/27/2004	9/27/2004	10/4/2004	10/4/2004	10/13/2004	10/13/2004
Metals									
Arsenic	(mg/kg)	57	13	3	4	3	4	3	6
Copper	(mg/kg)	390	105	18	27	22	36	23	58
Lead	(mg/kg)	450	109	5	12	4	10	6	24
Mercury	(mg/kg)	0.41	**0.68**	0.06	0.40	<0.06 U	0.09	0.14	0.30
Zinc	(mg/kg)	410	132	26	38	30	40	33	62
TOC	(%)	-	1.07	0.634	0.843	0.957	1.63	0.845	1.38
PCBs	(mg/kg - OC Normalized)	12	3 J	*	*	*	4	*	7
PCBs	(µg/kg - Dry Weight)	130[3]	*	<20 U	110	<20 U	*	42	*
LPAHs	(mg/kg - OC Normalized)	370	150	*	*	*	0.42	*	12
LPAHs	(µg/kg - Dry Weight)	5200[3]	*	235	1219	<6.3 U	*	9	*
HPAHs	(mg/kg - OC Normalized)	960	243	*	*	*	5	*	72
HPAHs	(µg/kg - Dry Weight)	12000[3]	*	464	1786	<6.3 U	*	242	*
TBT	(mg/kg - OC Normalized)	76[4]	NA	*	*	*	NA	*	NA
TBT	(µg/kg - Dry Weight)	1335[5]	*	NA	NA	NA	*	NA	*
Bioassay	-	SMS[6]	NA	NA	NA	NA	NA	NA	NA

Table 3.1
Final Progress Sampling Results

Analytes	Units	Compliance Criteria[2]	Sampling Locations[1]						
			SMA 2						
			TSP-02-01[7]	TSP-02-02[7]	TSP-02-03	TSP-02-04	TSP-02-05	TSP-02-06	TSP-02-07
			10/24/2004	10/24/2004	9/27/2004	9/27/2004	10/4/2004	10/4/2004	10/13/2004
Metals									
Arsenic	(mg/kg)	57	NR	NR	34 J	4	12	6	5
Copper	(mg/kg)	390	NR	NR	86	17	47	49	21
Lead	(mg/kg)	450	NR	NR	61 J	10	32	20	12
Mercury	(mg/kg)	0.41	NR	NR	0.27 J	<0.06 U	0.28	**0.71**	0.18
Zinc	(mg/kg)	410	NR	NR	214	29	76	58	36
TOC	(%)	-	NR	NR	0.772	0.273	0.968	1.18	1.56
PCBs	(mg/kg - OC Normalized)	12	NR	NR	*	*	*	<2 U	3
PCBs	(µg/kg - Dry Weight)	130[3]	NR	NR	74	<19 U	42	*	*
LPAHs	(mg/kg - OC Normalized)	370	NR	NR	*	*	*	3	4
LPAHs	(µg/kg - Dry Weight)	5200[3]	NR	NR	225	57	180	*	*
HPAHs	(mg/kg - OC Normalized)	960	NR	NR	*	*	*	10	19
HPAHs	(µg/kg - Dry Weight)	12000[3]	NR	NR	1915	367	825	*	*
TBT	(mg/kg - OC Normalized)	76[4]	NR	NR	*	*	*	<0.45 U	0.77
TBT	(µg/kg - Dry Weight)	1335[5]	NR	NR	150 J	<5.6 U	58	*	*
Bioassay	-	SMS[6]	Pass	**Fail**	NA	NA	NA	NA	NA

Table 3.1
Final Progress Sampling Results

Analytes	Units	Compliance Criteria[2]	Sampling Locations[1]						
			SMA 2		SMA 3				
			TSP-02-08	TSP-02-09	TSP-03-01	TSP-03-02	TSP-03-03	TSP-03-04	TSP-03-05
			10/13/2004	10/13/2004	2/11/2005	2/11/2005	12/8/2004	12/9/2004	2/11/2005
Metals									
Arsenic	(mg/kg)	57	8	6	7	7	7	<7 U	7
Copper	(mg/kg)	390	59	41	29	62	81	31	46.8
Lead	(mg/kg)	450	31	14 J	5	27	19 J	6	69
Mercury	(mg/kg)	0.41	**0.48**	0.18	0.07	**0.85**	0.35	0.08	0.38
Zinc	(mg/kg)	410	72	48	37	76.8	66	42	142
TOC	(%)	-	1.59	2.78	0.944	0.768	0.727	0.738	0.773
PCBs	(mg/kg - OC Normalized)	12	2	2	*	*	*	*	*
PCBs	(µg/kg - Dry Weight)	130[3]	*	*	<20 U	32	108 J	<20 U	17 J
LPAHs	(mg/kg - OC Normalized)	370	10	6	*	*	*	*	*
LPAHs	(µg/kg - Dry Weight)	5200[3]	*	*	<6.6 U	336	414	41	354
HPAHs	(mg/kg - OC Normalized)	960	44	16	*	*	*	*	*
HPAHs	(µg/kg - Dry Weight)	12000[3]	*	*	35	1872	1409 J	187	1446
TBT	(mg/kg - OC Normalized)	76[4]	6	0.86	*	*	*	*	*
TBT	(µg/kg - Dry Weight)	1335[5]	*	*	<4.3 U	36	79	5	7.6
Bioassay	-	SMS[6]	NA	NA	NA	NA	NA	NA	NA

Table 3.1
Final Progress Sampling Results

Analytes	Units	Compliance Criteria[2]	Sampling Locations[1] SMA 3 TSP-03-06 2/23/2005	TSP-03-07 2/11/2005	TSP-03-08 12/13/2004	TSP-03-09 12/13/2004	TSP-03-10 12/22/2004	TSP-03-11 12/13/2004	TSP-03-12 12/13/2004
Metals									
Arsenic	(mg/kg)	57	<6 U	14	12	8	7	<7 U	<7 U
Copper	(mg/kg)	390	47	112	30	59	33	16	13
Lead	(mg/kg)	450	17	48	15	16	9	4	9
Mercury	(mg/kg)	0.41	**1.04**[8]	**0.66**	<0.07 U	0.22	0.07	<0.07 U	<0.06 U
Zinc	(mg/kg)	410	42	109	74	65	56	29	26
TOC	(%)	-	0.882	1.22	0.388	0.791	1.07	0.742	1.6
PCBs	(mg/kg - OC Normalized)	12	*	6 J	*	*	<2 U	*	<1 U
PCBs	(µg/kg - Dry Weight)	130[3]	<20 U	*	20	74	*	<20 U	*
LPAHs	(mg/kg - OC Normalized)	370	*	24	*	*	2	*	<0.41 U
LPAHs	(µg/kg - Dry Weight)	5200[3]	16	*	163	38	*	15	*
HPAHs	(mg/kg - OC Normalized)	960	*	103	*	*	14	*	<0.41 U
HPAHs	(µg/kg - Dry Weight)	12000[3]	410	*	78	251	*	105	*
TBT	(mg/kg - OC Normalized)	76[4]	*	34.43	*	*	<0.38 U	*	<0.27 U
TBT	(µg/kg - Dry Weight)	1335[5]	<4.2 U	*	<4.3 U	10	*	<4.1 U	*
Bioassay	-	SMS[6]	NA	NA	NA	NA	NA	NA	NA

Table 3.1
Final Progress Sampling Results

Analytes	Units	Compliance Criteria[2]	Sampling Locations[1]						
			SMA 3	SMA 4					
			TSP-03-13	TSP-04-01	TSP-04-02	TSP-04-03	TSP-04-04	TSP-04-05	TSP-04-06
			12/22/2004	1/20/2005	2/4/2005	1/24/2005	1/7/2005	1/20/2005	1/7/2005
Metals									
Arsenic	(mg/kg)	57	<6 U	<6 U	7	14	8	7	<7 U
Copper	(mg/kg)	390	10	84	25	90	55	54	17
Lead	(mg/kg)	450	3	10	5	26	17	14	<3 U
Mercury	(mg/kg)	0.41	<0.04 U	0.24	<0.06 U	0.21	0.25	0.17	<0.07 U
Zinc	(mg/kg)	410	22	53	32	100	48	50	23
TOC	(%)	-	0.869	0.404	0.592	0.509	1.04	0.809	0.703
PCBs	(mg/kg - OC Normalized)	12	*	*	*	*	<1.83 U	*	*
PCBs	(µg/kg - Dry Weight)	130[3]	<19 U	<20 U	<19 U	87[9]	*	<20 U	<19 U
LPAHs	(mg/kg - OC Normalized)	370	*	*	*	*	10.57	*	*
LPAHs	(µg/kg - Dry Weight)	5200[3]	11	80	133	131	*	12	<6 U
HPAHs	(mg/kg - OC Normalized)	960	*	*	*	*	48	*	*
HPAHs	(µg/kg - Dry Weight)	12000[3]	25	204	27	511	*	125	<6 U
TBT	(mg/kg - OC Normalized)	76[4]	*	*	*	*	7	*	*
TBT	(µg/kg - Dry Weight)	1335[5]	<4.3 U	92 J	6	150	*	34	<4 U
Bioassay	-	SMS[6]	NA	NA	NA	NA	NA	NA	NA

Table 3.1
Final Progress Sampling Results

Analytes	Units	Compliance Criteria2	Sampling Locations[1]				
			SMA 4				
			TSP-04-07	TSP-04-08	TSP-04-09	TSP-04-10	TSP-04-11
			1/12/2005	2/4/2005	1/20/2005	1/14/2005	1/14/2005
Metals							
Arsenic	(mg/kg)	57	<6 U	7	<6 U	8.82	12
Copper	(mg/kg)	390	31	25	18	45.3	120
Lead	(mg/kg)	450	5	3	4	13	17
Mercury	(mg/kg)	0.41	<0.06 U	<0.07 U	0.3	0.31	0.10
Zinc	(mg/kg)	410	31	30	31	50	122
TOC	(%)	-	0.727	0.554	0.904	1.37	0.863
PCBs	(mg/kg - OC Normalized)	12	*	*	*	<1 U	*
PCBs	(µg/kg - Dry Weight)	130[3]	<20 U	<19 U	<20 U	*	<20 U
LPAHs	(mg/kg - OC Normalized)	370	*	*	*	4	*
LPAHs	(µg/kg - Dry Weight)	5200[3]	20	<6 U	28	*	16
HPAHs	(mg/kg - OC Normalized)	960	*	*	*	28	*
HPAHs	(µg/kg - Dry Weight)	12000[3]	279	<6 U	62 J	*	177
TBT	(mg/kg - OC Normalized)	76[4]	*	*	*	1	*
TBT	(µg/kg - Dry Weight)	1335[5]	4	<4.1 U	5	*	90
Bioassay	-	SMS[6]	NA	NA	NA	NA	NA

Table 3.1
Final Progress Sampling Results

Analytes	Units	Compliance Criteria[2]	Sampling Locations[1]			
			SMA 5			
			TSP-05-01	TSP-05-02	TSP-05-03	TSP-05-04
			11/30/2004	11/30/2004	2/21/2005	11/30/2004
Metals						
Arsenic	(mg/kg)	57	<7 U	10	<7 U	7
Copper	(mg/kg)	390	16	29	31	21
Lead	(mg/kg)	450	4	13	3	6
Mercury	(mg/kg)	0.41	<0.05 U	<0.1 U	<0.07 U	<0.05 U
Zinc	(mg/kg)	410	26	78	34	43
TOC	(%)	-	1.25	0.993	0.840	0.786
PCBs	(mg/kg – OC Normalized)	12	<2 U	*	*	*
PCBs	(μg/kg – Dry Weight)	130[3]	*	<20 U	<19 U	<20 U
LPAHs	(mg/kg – OC Normalized)	370	1	*	*	*
LPAHs	(μg/kg – Dry Weight)	5200[3]	*	<7 U	38	<7 U
HPAHs	(mg/kg – OC Normalized)	960	<1 U	*	*	*
HPAHs	(μg/kg – Dry Weight)	12000[3]	*	<7 U	38	<7 U
TBT	(mg/kg – OC Normalized)	76[4]	<0.47 U	*	*	*
TBT	(μg/kg – Dry Weight)	1335[5]	*	20	<4 U	<5.9 U
Bioassay	-	SMS[6]	NA	NA	NA	NA

Table 3.1
Final Progress Sampling Results

Analytes	Units	Compliance Criteria[2]	Sampling Locations[1] SMA 6 TSP-06-01 9/9/2005	TSP-06-05 9/14/2005	TSP-06-06 9/27/2005	TSP-06-07 9/27/2005	TSP-06-08 9/27/2005
Metals							
Arsenic	(mg/kg)	57	13	10	11	21	30
Copper	(mg/kg)	390	40	26	43	111	**569**
Lead	(mg/kg)	450	24	97	116	227	**454**
Mercury	(mg/kg)	0.41	**0.64**	**0.50**	**0.92**	**1.56**	**12.60**
Zinc	(mg/kg)	410	78	84 J	215	334	**485**
TOC	(%)	-	0.60	2.35	1.20	1.28	1.34
PCBs	(mg/kg - OC Normalized)	12	*	3	<2 U	<1 U	4.78
PCBs	(μg/kg - Dry Weight)	130[3]	<19 U	*	*	*	*
LPAHs	(mg/kg - OC Normalized)	370	*	127	325	**598**	**443**
LPAHs	(μg/kg - Dry Weight)	5200[3]	4,208	*	*	*	*
HPAHs	(mg/kg - OC Normalized)	960	*	145	286	919	**2,114**
HPAHs	(μg/kg - Dry Weight)	12000[3]	2,078	*	*	*	*
TBT	(mg/kg - OC Normalized)	76[4]	*	<0.2 U	<0.3 U	<0.3 U	<0.3 U
TBT	(μg/kg - Dry Weight)	1335[5]	<3.7 U	*	*	*	*
Bioassay	-	SMS[6]	NA	NA	NA	NA	NA

Table 3.1
Final Progress Sampling Results

Analytes	Units	Compliance Criteria[2]	Sampling Locations[1]						
			SMA 7						
			TSP-07-01	TSP-07-02	TSP-07-03	TSP-07-04	TSP-07-05	TSP-07-06	TSP-07-07
			9/30/2005	9/30/2005	10/12/2005	10/12/2005	9/30/2005	10/12/2005	9/29/2005
Metals									
Arsenic	(mg/kg)	57	17	11	8	8	10	<6 U	53
Copper	(mg/kg)	390	87	31	15	13	48	9	96
Lead	(mg/kg)	450	49	14	<3 U	<3 U	31	<2 U	95
Mercury	(mg/kg)	0.41	**0.43**	0.25	<0.06 U	<0.06 U	**0.53**	<0.06 U	0.35
Zinc	(mg/kg)	410	118	45	26	24	68	22	378
TOC	(%)	-	1.07	0.896	1.93	3.9	0.353	0.269	0.457
PCBs	(mg/kg - OC Normalized)	12	6	*	<1.0 U	<0.49 U	*	*	*
PCBs	(μg/kg - Dry Weight)	130[3]	*	<19 U	*	*	52	<20 U	100
LPAHs	(mg/kg - OC Normalized)	370	52	*	0.44	<0.17 U	*	*	*
LPAHs	(μg/kg - Dry Weight)	5200[3]	*	120	*	*	550	<6.0 U	420
HPAHs	(mg/kg - OC Normalized)	960	257	*	1.2	0.26	*	*	*
HPAHs	(μg/kg - Dry Weight)	12000[3]	*	585	*	*	1,448	<6.0 U	2,783
TBT	(mg/kg - OC Normalized)	76[4]	24	*	<0.18 U	<0.09 U	*	*	*
TBT	(μg/kg - Dry Weight)	1335[5]	*	14	*	*	48	<3.4 U	33
Bioassay	-	SMS[6]	NA	NA	NA	NA	NA	NA	NA

Table 3.1
Final Progress Sampling Results

Analytes	Units	Compliance Criteria[2]	Sampling Locations[1]						
			SMA 8						
			TSP-08-01	TSP-08-02	TSP-08-03	TSP-08-04	TSP-08-05	TSP-08-06	TSP-08-07
			10/18/2005	10/28/2005	10/18/2005	10/28/2005	10/28/2005	10/20/2005	10/28/2005
Metals									
Arsenic	(mg/kg)	57	8	7	15	10	10	29	34
Copper	(mg/kg)	390	19	19	30	64	25	65	66
Lead	(mg/kg)	450	8	23	21	33	10	128	121
Mercury	(mg/kg)	0.41	<0.06 U	<0.06 U	0.06	0.12	0.15	0.22	**0.43**
Zinc	(mg/kg)	410	73	51 J	84	74 J	44 J	237	270 J
TOC	(%)	-	0.866	0.672	0.177	0689	0.56	0.596	0.387
PCBs	(mg/kg - OC Normalized)	12	*	*	*	*	*	*	*
PCBs	(µg/kg - Dry Weight)	130[3]	<33 U	<20 U	<34 U	47	<19 U	53	30
LPAHs	(mg/kg - OC Normalized)	370	*	*	*	*	*	*	*
LPAHs	(µg/kg - Dry Weight)	5200[3]	57	213	37	**9,219**	681	644	94
HPAHs	(mg/kg - OC Normalized)	960	*	*	*	*	*	*	*
HPAHs	(µg/kg - Dry Weight)	12000[3]	448	639	484	7,715	866	2,181	926
TBT	(mg/kg - OC Normalized)	76[4]	*	*	*	*	*	*	*
TBT	(µg/kg - Dry Weight)	1335[5]	<6 U	<4 U	43	6	<4 U	12	<4 U
Bioassay	-	SMS[6]	NA	NA	NA	NA	NA	NA	NA

Table 3.1
Final Progress Sampling Results

Analytes	Units	Compliance Criteria[2]	Sampling Locations[1]			
			SMA 8	SMA 9		
			TSP-08-08	TSP-09-01	TSP-09-02	TSP-09-03
			11/16/2005	11/11/2005	11/2/2005	11/2/2005
Metals						
Arsenic	(mg/kg)	57	<7 U	<7 U	<7 U	25
Copper	(mg/kg)	390	27	12	25	66
Lead	(mg/kg)	450	4	4	4	46
Mercury	(mg/kg)	0.41	<0.05 U	<0.06 U	<0.05 U	0.38
Zinc	(mg/kg)	410	32	26	30	167
TOC	(%)	-	0.614	0.832	1.08	0.931
PCBs	(mg/kg - OC Normalized)	12	*	*	<2 U	*
PCBs	(µg/kg - Dry Weight)	130[3]	<20 U	<18 U	*	<20 U
LPAHs	(mg/kg - OC Normalized)	370	*	*	1	*
LPAHs	(µg/kg - Dry Weight)	5200[3]	<6 U	146	*	99
HPAHs	(mg/kg - OC Normalized)	960	*	*	3	*
HPAHs	(µg/kg - Dry Weight)	12000[3]	13	382	*	836
TBT	(mg/kg - OC Normalized)	76[4]	*	*	<0.3 U	*
TBT	(µg/kg - Dry Weight)	1335[5]	<4 U	<3.4 U	*	<3.7 U
Bioassay	-	SMS[6]	NA	NA	NA	NA

Notes:

*	Sample result not compared to compliance criteria (dependent on TOC value).
NA	Analysis not performed (per RASAP requirements).
NR	Chemical analysis not reported due to results being superceded by bioassay results.
U	Compound undetected at the reported concentration.
1	Sampling locations based on RASAP Figure 5.1.
2	Compliance criteria based on SQS chemical criteria per Washington State Sediment Management Standards (SMS; Chapter 173-204 WAC), unless otherwise noted.
3	Compliance criteria based on Lowest Apparent Effects Threshold (LAET) chemical criteria per "1988 Update and Evaluation of Puget Sound AET" (Barrick, Becker, Brown, Beller, and Pastorak) where total organic carbon value is less than 1%.
4	Compliance criteria based on confirmational number stated in the 2002 Explanation of Significant Differences.
5	Compliance criteria based on the dry weight concentration is used when the total organic carbon value is less than 1%.
6	Compliance criteria based on SMS Bioassay Testing Results.
7	Results are for a sediment composite sample collected in the vicinity of the sample location for bioassay testing.
8	Sample re-analyzed for mercury. Initial concentration was 5.13 ppm.
9	Sample re-analyzed for PCBs. Initial concentration was 136 ppb.

Bold indicates analytical result exceeds compliance criteria.

Table 4.1
Dredge Material Weight and Volume Summary

SMA Designation	Dredge Material Weight in Tons[1]	Estimated Dredge Material Volume in Cubic Yards[2]
SMAs 1 and 2	50,713	35,217
SMA 3	77,619	53,902
SMA 3 Initial Dredge	*36,101*	*25,070*
SMA 3 Redredge	*36,036*	*25,025*
SMA 3 2nd Redredge	*4,426*	*3,074*
SMA 3 3rd Redredge	*1,056*	*733*
SMA 4	52,524	36,475
SMA 4 Initial Dredge	*42,616*	*29,595*
SMA 4 Redredge	*7,767*	*5,394*
SMA 4 2nd Redredge	*2,141*	*1,486*
SMA 5	22,266	15,463
SMA 5 Initial Dredge	*18,135*	*12,594*
SMA 5 Redredge	*2,550*	*1,771*
SMA 5 2nd Redredge	*1,581*	*1,098*
SMA 6	30,596	21,247
SMA 6 Initial Dredge	*26,619*	*18,485*
SMA 6 Redredge	*3,977*	*2,762*
SMA 7	19,878	13,804
SMA 7 Initial Dredge 04-05	*5,421*	*3,765*
SMA 7 Initial Dredge 05-06	*11,531*	*8,008*
SMA 7 Redredge	*2,926*	*2,032*
SMA 8	47,005	32,642
SMA 8 Initial Dredge 04-05	*27,679*	*19,222*
SMA 8 Initial Dredge 05-06	*11,803*	*8,197*
SMA 8 Redredge	*5,391*	*3,744*
SMA 8 2nd Redredge	*2,132*	*1,481*

SMA Designation	Dredge Material Weight in Tons[1]	Estimated Dredge Material Volume in Cubic Yards[2]
SMA 9	15,762	10,946
SMA 9 Initial Dredge 04-05	*3,095*	*2,149*
SMA 9 Initial Dredge 05-06	*10,817*	*7,512*
SMA 9 Redredge	*1,850*	*1,285*
Total	**316,363**	**219,697**

Notes:

1 Material weights obtained from daily barge displacement charts and dredge reports.

2 Volumes calculated using an experience based conversion factor of 1.44 ton/cy.

Table 4.2
Under-pier Capping Summary at Pier 6

Date of Under-pier Cap Material Placement	Number of Pier Bays Capped[1]	Volume Placed in Cubic Yards[1]	Placement Area in Square Feet[1]
10/13/2004	5	60	1,500
10/18/2004 to 10/19/2004	19	220	5,700
10/19/2004 to 10/20/2004	17	210	5,100
10/21/2004	8	101	2,400
11/10/2004 to 11/11/2004	20	240	6,000
11/11/2004 to 11/12/2004	13	172	3,900
11/12/2004 to 11/13/2004	9	139	3,000
11/13/2004 to 11/14/2004	7	87	2,100
Totals	**98**	**1,229**	**29,700**
Average Cap Material Thickness in Feet: 1.1			

Notes:

1 Data obtained from GCC daily construction reports.

QA/QC Input Criteria

a Average Bay Area—300 square feet (the bay area is the area between adjacent piling bents, extending from approximately 8 feet outside the pier face to pier centerline).
b Total Number of Bays—98.
c Required Cap Thickness—1 foot.
d Total Under-pier Area to be Capped—29,400 square feet.
e Total Under-pier Volume to be Placed—1,089 cubic yards.

Table 4.3
Summary of In-water Fill Material Quantities

Site Area	Weight of In-water Fill Material Placed In Tons							Type 1 Habitat Mix		
	Gravelly Sand Cap	Riprap	Subtidal Depression Fill	Boundary Sand[1]	Sand Cover[2]	SMA 3 Supplemental Sand Cap	Type 2 Habitat Mix	Weight Placed in Tons	Area Of Placement in Square Feet	Placement Rate in Tons Per 1,000 Square Feet[3]
SMAs 1 and 2 (NE Shoreline)	21,793	23,614	-	180	-	-	-	1,917	49,700	39
SMA 3	-	-	1,325	-	-	1,035	-	552	14,700	38
SMA 4	-	-	-	-	-	-	-	1,048	35,000	30
SMA 5	-	-	399	330	-	-	-	-	-	-
SMA 6	-	15,649	-	-	3,228	-	3,923	-	-	-
SMA 7	-	-	2,982	122	-	-	-	-	-	-
SMA 8	-	-	-	-	-	-	-	-	-	-
SMA 9	-	-	-	298	-	-	-	-	-	-
Totals	**21,883**	**39,263**	**4,706**	**840**	**3,228**	**1,035**	**3,923**	**3,517**	**99,400**	**35**

Notes:
1 Refer to Figure 3.2 for locations of boundary sand placement.
2 Sand cover was placed below Type 2 Habitat Mix in the habitat bench in SMA 6.
3 Specified placement rate for habitat mix is 25 tons per 1,000 square feet.

Table 4.4
Summary of Material Placed at TSSOU Boundary

Site Area	Length of SMA Boundary where Boundary Sand was Placed in Lineal Feet[1]	Quantity of Boundary Sand Placed in Tons	Quantity of Boundary Sand Placed in Cubic Yards[2]	Placement Rate in Cubic Yards/ Lineal Foot[3]
SMA 1	100	180	125.0	1.25
SMA 5	210	330	229.2	1.09
SMA 7	55	122	84.7	1.54
SMA 9	110	298	206.9	1.88

Notes:
1. Refer to Figure 3.2 for locations of boundary sand placement.
2. Conversion rate = 1.44 tons/cubic yards.
3. Specified placement rate for boundary sand is 1.07 cubic yards per lineal foot.

Table 4.5
Under-pier Capping Summary at Pier 6P[1]

Date of Under-pier Cap Material Placement	Volume Placed in Cubic Yards[2]	Placement Area in Square Feet[2]
10/21/2004	132	3,300
11/11/04 to 11/12/04	44	1,000
11/12/04 to 11/13/04	125	2,700
11/13/04 to 11/14/04	87	2,100
11/14/04 to 11/15/04	198	3,600
Totals	**586**	**12,700**
Average Cap Material Thickness in Feet: 1.2		

Notes:
1 Conclusions about the adequacy of capping of the Pier 6P area are presented in Section 5.2.2.1.
2 Data obtained from GCC daily construction reports.

QA/QC Input Criteria
a Required Cap Thickness—1 foot.
b Total Under-pier Area to be Capped—14,710 square feet.
c Total Under-pier Volume to be Placed—544.81 cubic yards.

Table 4.6
Under-pier Capping Summary at Pier 5

Date of Under-pier Cap Material Placement	Number of Pier Bays Capped[1]	Volume Placed in Cubic Yards[1]	Placement Area in Square Feet[1]
11/16/2004 to 11/17/04	5	500	4,500
11/17/04 to 11/18/04	6	600	5,400
11/18/20 to 11/19/04	6	600	5,400
11/19/04 to 11/20/04	7	700	6,300
11/22/04 to 11/23/04	6	600	5,400
11/23/04 to 11/24/04 and 11/24/04 to 11/25/04	6	600	6,300
1/22/05 to 1/23/05	6	600	5,400
1/23/05 to 1/24/05	6	600	5,400
1/24/05 to 1/25/05	6	600	5,400
1/25/05 to 1/26/05 and 1/26/05 to 1/27/05	8	800	7,200
1/27/05 to 1/28/05 and 1/28/05 to 1/29/05	10	1,035	9,315
Totals	**72**	**7,235**	**66,015**
Average Cap Material Thickness in Feet: 3.0			

Notes:

1 Data obtained from GCC daily construction reports.

QA/QC Input Criteria

a Average Bay Area—900 square feet (the bay area is the area between adjacent piling bents, extending from approximately 8 feet outside the pier face to pier centerline).

b Total Number of Bays—72.

c Required Cap Thickness—3 feet.

d Total Under-pier Area to be Capped—64,800 square feet.

e Total Under-pier Volume to be Placed—7,200 cubic yards.

Table 4.7
Under-pier Capping Summary at Pier 4N

Date of Under-pier Cap Material Placement	Number of Pier Bays Capped[1]	Volume Placed in Cubic Yards[1]	Placement Area in Square Feet[1]
12/13/04 to 12/14/04	7	539	4,900
12/14/04 to 12/15/04	6	434	4,200
12/15/04 to 12/16/04	11	875	7,700
12/16/04 to 12/17/04	6	428	3,733
12/17/04 to 12/18/04	4	416.5	4,200
2/3/2005	6	500	4,200
2/4/2005	7.5	609	5,116
2/21/2005	0.5	39	323
2/22/2005	6	486	4,374
2/23/05 to 2/24/05	6	464	3,742
Totals	**60**	**4,790.5**	**42,488**
Average Cap Material Thickness in Feet: 3.0			

Notes:
1 Data obtained from GCC daily construction reports.

QA/QC Input Criteria
- a Average Bay Area—700 square feet (the bay area is the area between adjacent piling bents, extending from approximately 8 feet outside the pier face to pier centerline).
- b Total Number of Bays—60.
- c Required Cap Thickness—3 feet.
- d Total Under-pier Area to be Capped—42,000 square feet.
- e Total Under-pier Volume to be Placed—4,667 cubic yards.

Table 4.8
Under-pier Capping Summary at Piers 1, 1A, 2P, 3 and the Building Berth

Date of Under-pier Cap Material Placement	Number of Pier Bays Capped[1]	Volume Placed in Cubic Yards[1]	Placement Area in Square Feet[1]
11/2/05 to 11/3/05	0[2]	29	893
11/3/05 to 11/4/05	21	530	14,222
11/4/05 to 11/5/05	21	503	13,501
11/7/05 to 11/8/05	12	293	7,837
11/8/05 to 11/9/05	35	653	17,575
11/9/05 to 11/10/05	11[2,3]	680	18,304
Totals	**100**	**2,688**	**72,332**
Average Cap Material Thickness in Feet: 1.0			

Notes:

1 Data obtained from GCC daily construction reports.
2 On this day under-pier capping material was placed in the building berth area, which was not divided into pier bays.
3 On this day under-pier capping material was placed underneath Pier 1A, which was not divided into pier bays.

QA/QC Input Criteria

a The plan area within pier bays varied depending on location.
b Total Number of Bays beneath Piers 1, 2P and 3 = 100.
c Required Cap Thickness—1 foot.
d Total Area Capped—72,332 square feet.
e Total Volume Placed—2,688 cubic yards.

Table 5.1
Sediment Confirmational Sample Results Statistical Comparison to Compliance Criteria

Analyte	Units	Number of Samples	Average (Mean) Concentration	Upper 95% Confidence Limit on the Mean Concentration[1]	Sediment Quality Standard	Cleanup Screening Level	Confirmational Number West Waterway[2]
Arsenic	mg/kg	64	9.56	11.73	57	93	93
Copper	mg/kg	64	43.34	50.30	390	390	390
Lead	mg/kg	64	28.08	37.99	450	530	530
Mercury	mg/kg	64	0.25	0.33	0.41	0.59	1.34
Zinc	mg/kg	64	76.75	94.85	410	960	960
PCBs	mg/kg-OC	20	2.21	3.14	12	65	39
PCBs	µg/kg	44	27.17	35.85	130[3]	1,000[4]	591
LPAHs	mg/kg-OC	20	66.45	131.39	370	780	780
LPAHs	µg/kg	44	460.99	904.59	5,200[3]	13,000[4]	13,000
HPAHs	mg/kg-OC	20	110.64	203.30	960	5,300	5,300
HPAHs	µg/kg	44	778.21	1,159.69	12,000[3]	17,000[4]	69,000
TBT	mg/kg-OC	17	4.42	9.04	76[2]	NA	76
TBT	µg/kg	40	23.64	35.55	1335[5]	NA	1,335

Notes:
1 Upper 95% confidence level on the mean concentration calculations based on USEPA guidance (USEPA 1989).
2 Based on confirmational number stated in the 2002 Explanation of Significant Differences.
3 Compliance criteria based on Lowest Apparent Effects Threshold (LAET) chemical criteria per "1988 Update and Evaluation of Puget Sound AET" (Barrick, Becker, Brown, Beller, and Pastorak) where total organic carbon value is less than 1%.
4 Based on twice the Lowest Apparent Effects Threshold (LAET) chemical criteria per "1988 Update and Evaluation of Puget Sound AET".
5 Compliance criteria based on the dry weight concentration is used when the total organic carbon value is less than 1%.

Table 7.1
Construction Cost Summary

Task	Original Estimated Cost (2003)[1]	Actual Cost (2004-2006)
Pre-construction		
Mob/Demob, Site Preparation and Temporary Facilities	$326,000	$240,000
Demolition		
Demolish Pier 2 and Remove Piles	$312,000	$340,000
Demolish Pier 4S (including Buildings) and Remove Piles	$653,000	$630,000
Demolish Side Launch Shipways and Remove Piles	$200,000	$100,000
Dredging		
Remediation Dredging and Barge Dewatering	$3,817,000	$4,340,000
Pier 4S Debris Mound Excavation	$65,000	$0
Sediment Disposal		
Dredge Material Transload, Transportation, and Disposal Cost	$10,644,000	$10,120,000
Capping and Fill		
Under Pier Caps	$572,000	$600,000
Habitat Mix	$175,000	$310,000
Sand and Gravel Fill	$408,000	$560,000
Riprap	$513,000	$1,120,000
Shotcrete Cap at Debris Mound Beneath Pier 6P	$89,000	$50,000
Sand at TSSOU Boundary	$42,000	$10,000
Total Direct Costs	**$17,816,000**	**$18,420,000**
Indirect Costs		
Contractor Overhead	$1,262,000	$1,120,000
Surveys	$60,000	$40,000
Water Quality and Confirmational Sediment Monitoring	$310,000	$290,000
Agency Oversight Costs	**Not Estimated**	**$417,000**
Subtotal	**$19,448,000**	**$20,287,000**
Construction Contingency (5%)	**$972,000**	**N/A**
Total Construction Costs	**$20,420,000**	**$20,287,000**
Construction Management	$1,012,000	$430,000
Total Capital Costs	**$21,432,000**	**$20,717,000**

Notes:
Above costs include direct and indirect cost for construction but do not include contractor profit.
1 Costs are engineer's estimate at time of bid.

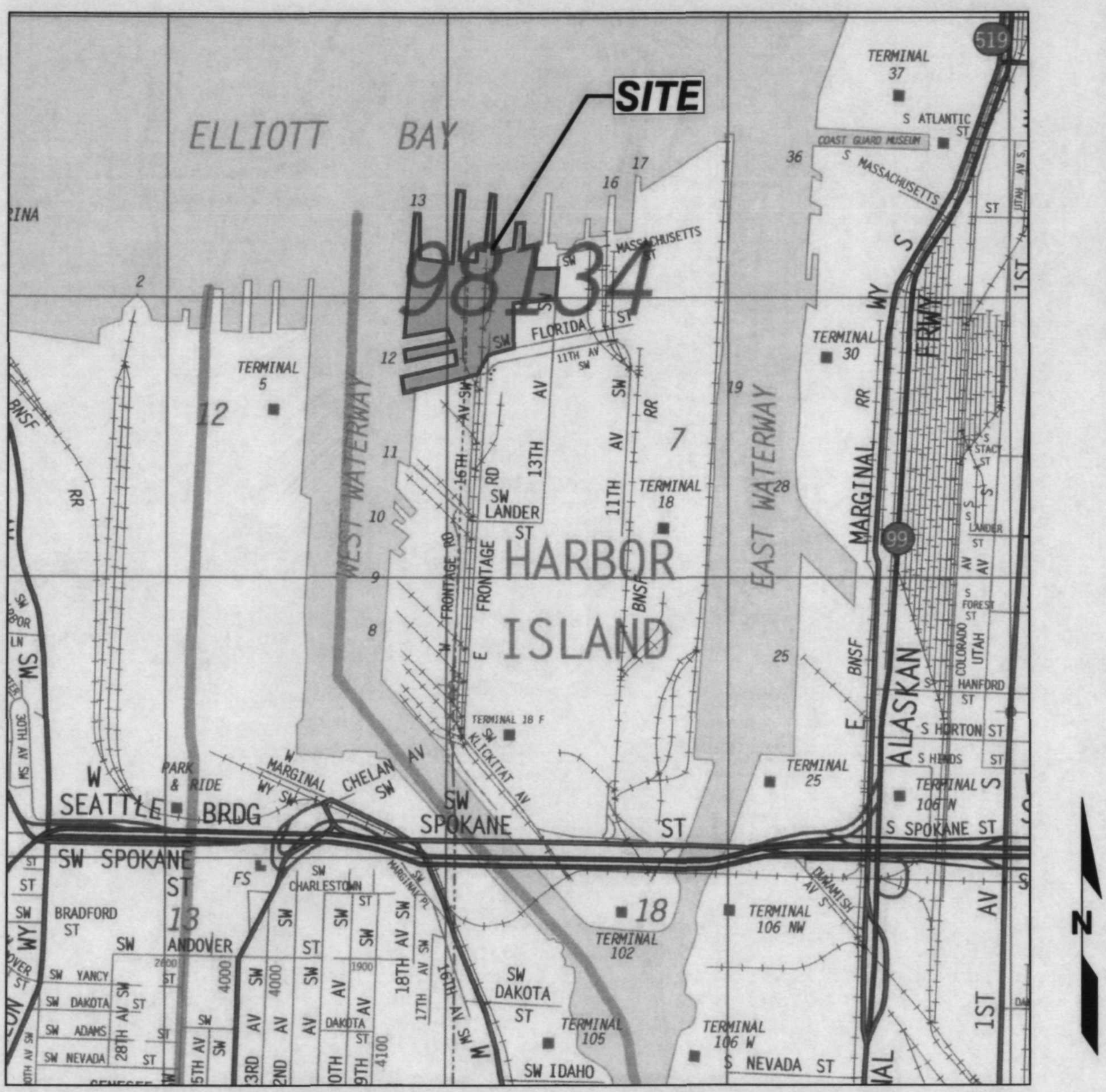
Figures

Remedial Action Completion Report

Todd Shipyards
Sediment Operable Unit

Figures

FINAL

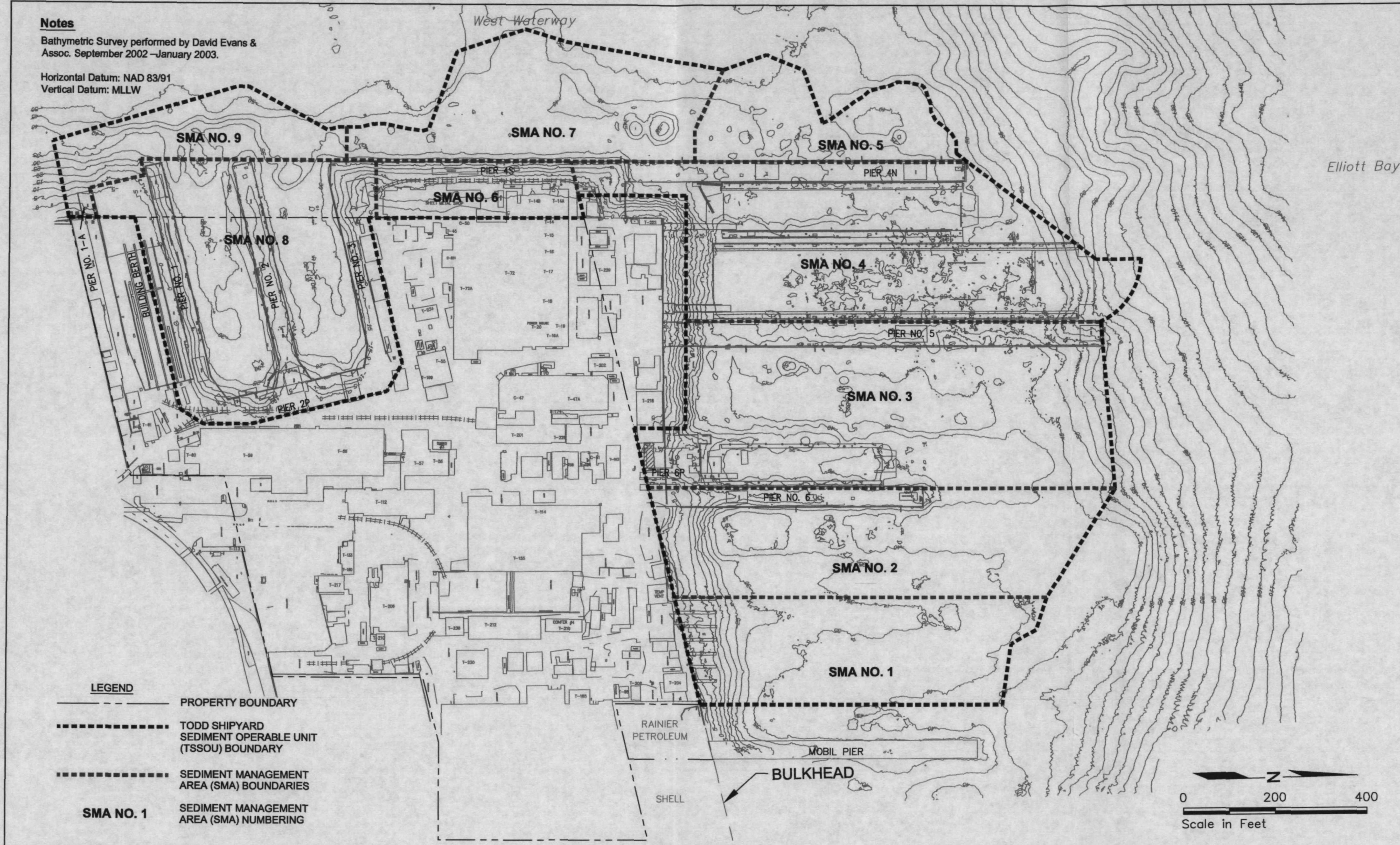


FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 1.1
Vicinity Map

01/09/04/fsm/todd/NewCorelFigures/RemedialActionCP/vicinity.cdr

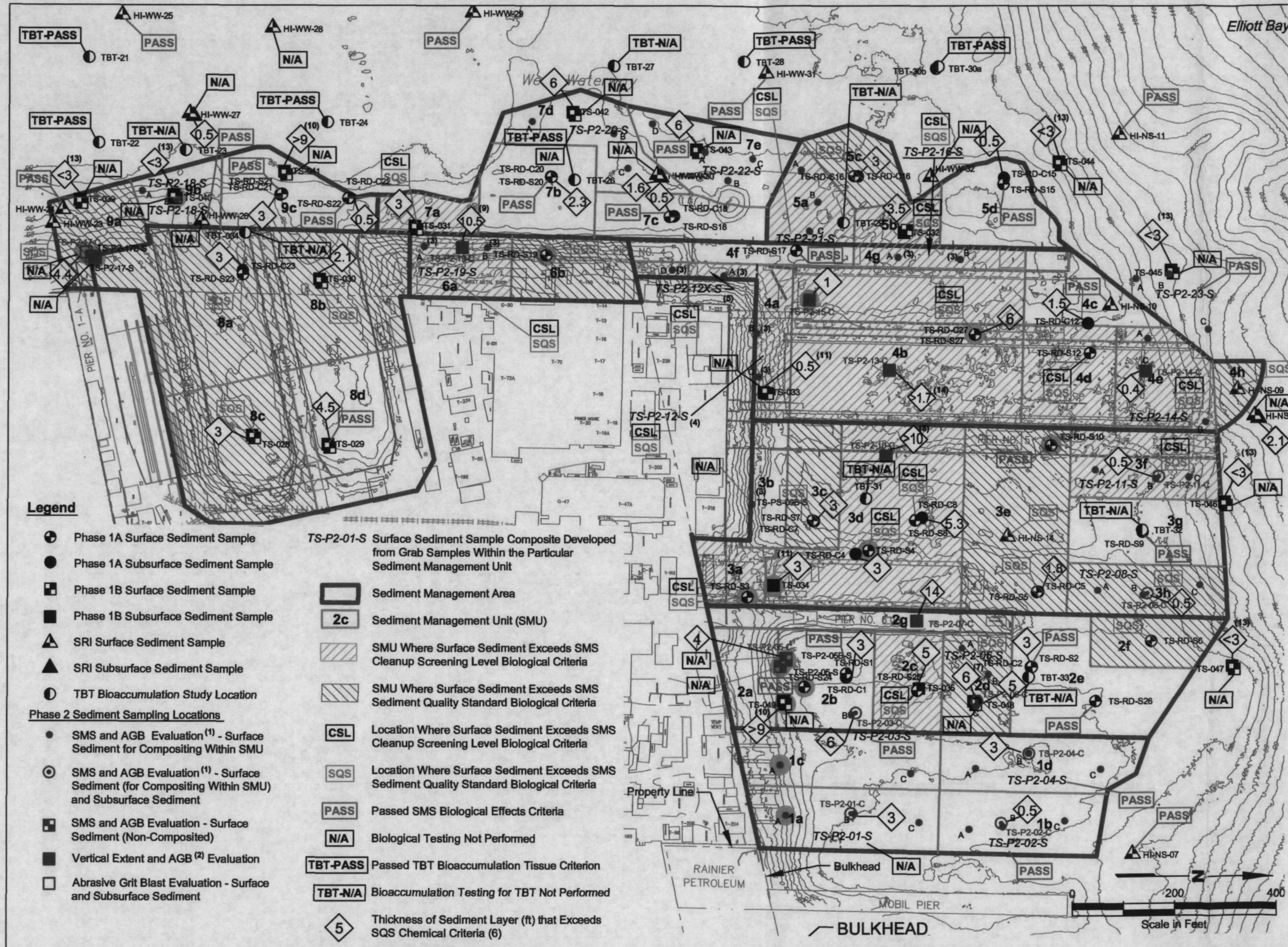


FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 2.1
Todd Pacific Shipyards Facility Base Map

DWG NAME: G:\project\Clients\Floyd and Snider\todd\technical\todd0141 (Facil Base Map).dwg
DATE: 03/16/06 08:29am



Notes

(1) Uncomposited samples from each of these locations were collected for AGB evaluation.

(2) A subsample from the surface interval of subsurface core samples was collected for AGB evaluation.

(3) Samples were collected by divers. Locations are approximated from diver measurements.

(4) Composite sample developed from locations B and C within SMU 4a.

(5) Composite sample developed from locations A and D within SMU 4a.

(6) At most locations, the thickness of the sediment layers that exceeded the SQS and CSL were the same; see Table 1 for exceptions.

(7) Depth of contamination exceeding SQS criteria determined to be 6 ft by Phase 1B investigation and 5ft by Phase 2 investigation.

(8) PAH contamination at TS-P2-10-C extends to a depth of at least 10 ft below mudline; no sediment intervals were collected below this depth.

(9) A very low level exceedance of the SQS for acenaphthene extends to a depth of 12 ft at this location.

(10) The thickness indicated is a minimum; no sediment intervals were collected below this depth.

(11) Core met with refusal at 2 to 3 ft; riprap present.

(12) No chemical or biological testing was conducted on surface sediment in SMUs 2a and 2g. No biological testing performed on surface sediment in SMUs 3b or 7d.

(13) Core data contained no SQS or CSL chemical exceedances at a depths greater than 3 ft below mudline; the 0.5 to 3.0 ft interval was not analyzed.

(14) Contamination above the CSL is greater than 1.7 ft deep but less than 2.9 ft deep.

Misc. Notes

Sample locations revised April 15, 2002 to reflect "actual" sample locations (vs "proposed" locations).

Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

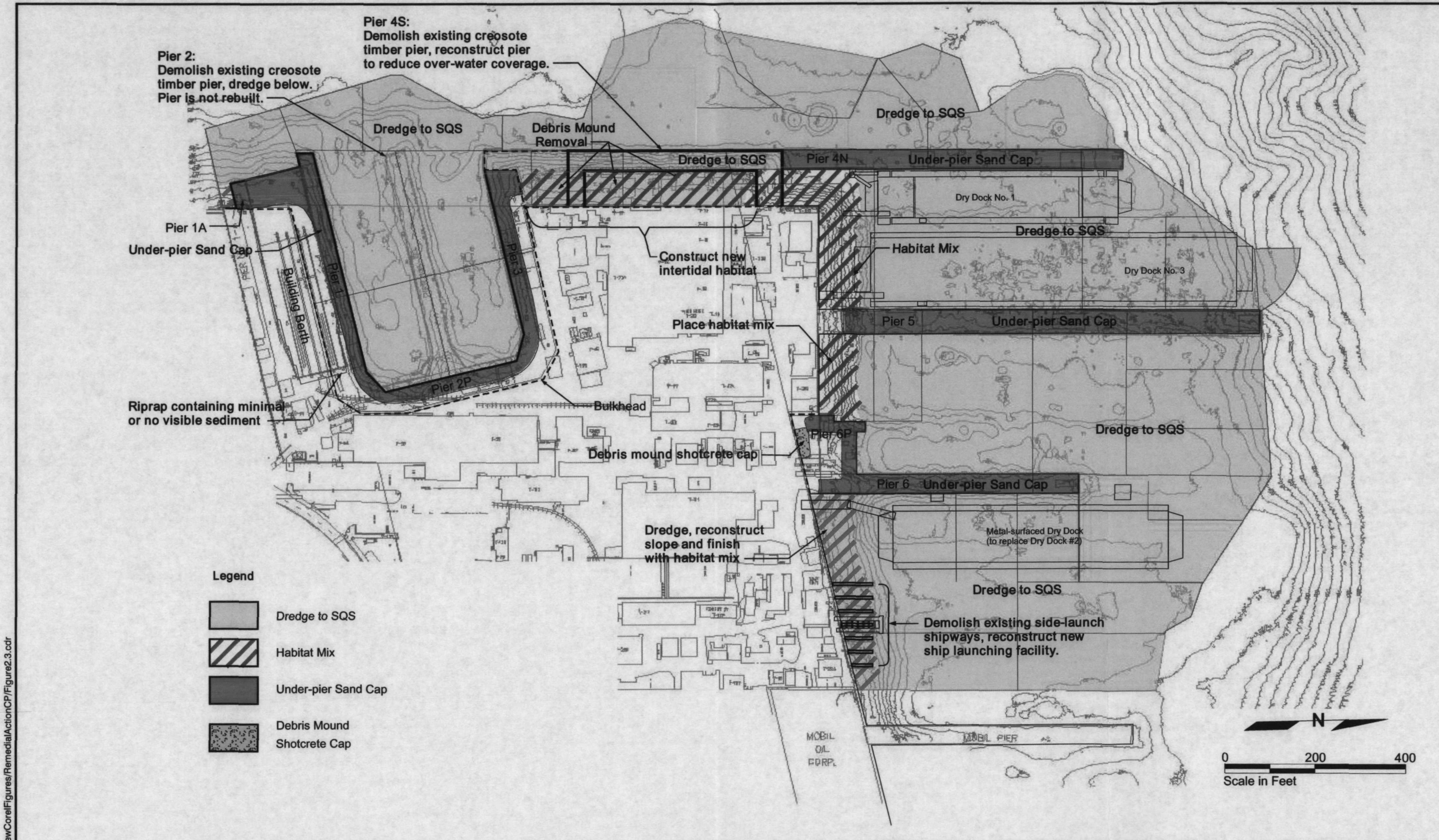
Bathymetric data were collected in September 2002 - January 2003. Mudline elevations in feet relative to mean lower low water.

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 2.2
Chemical, Biological, and AGB Testing Summary

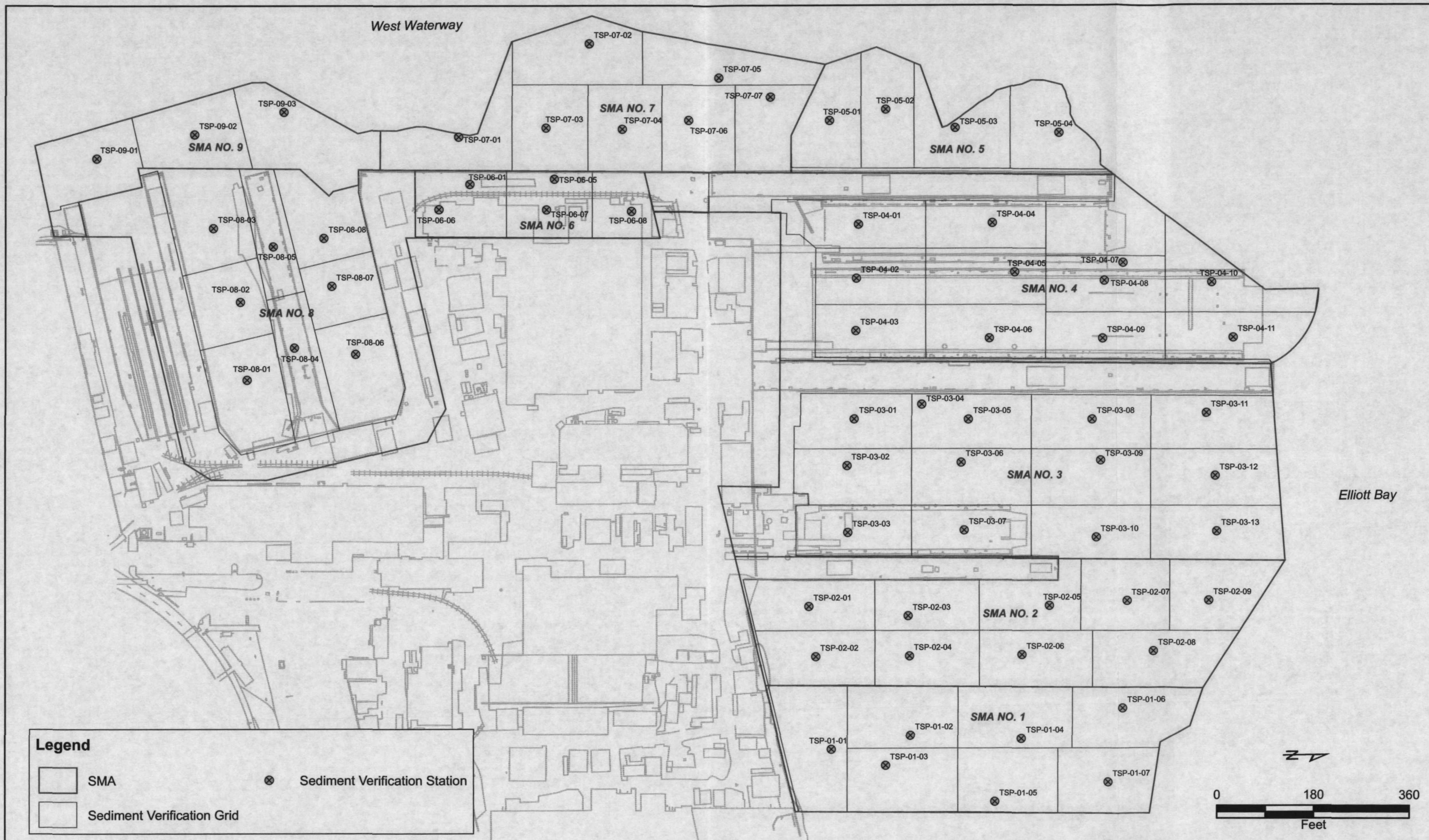
DWG NAME: G:\project\Clients\Floyd and Snider\todd\technical\todd0039_Jun2007update.dwg
DATE: 06/28/07 1:31pm



FLOYD | SNIDER
strategy • science • engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 2.3
Remedial Design Summary

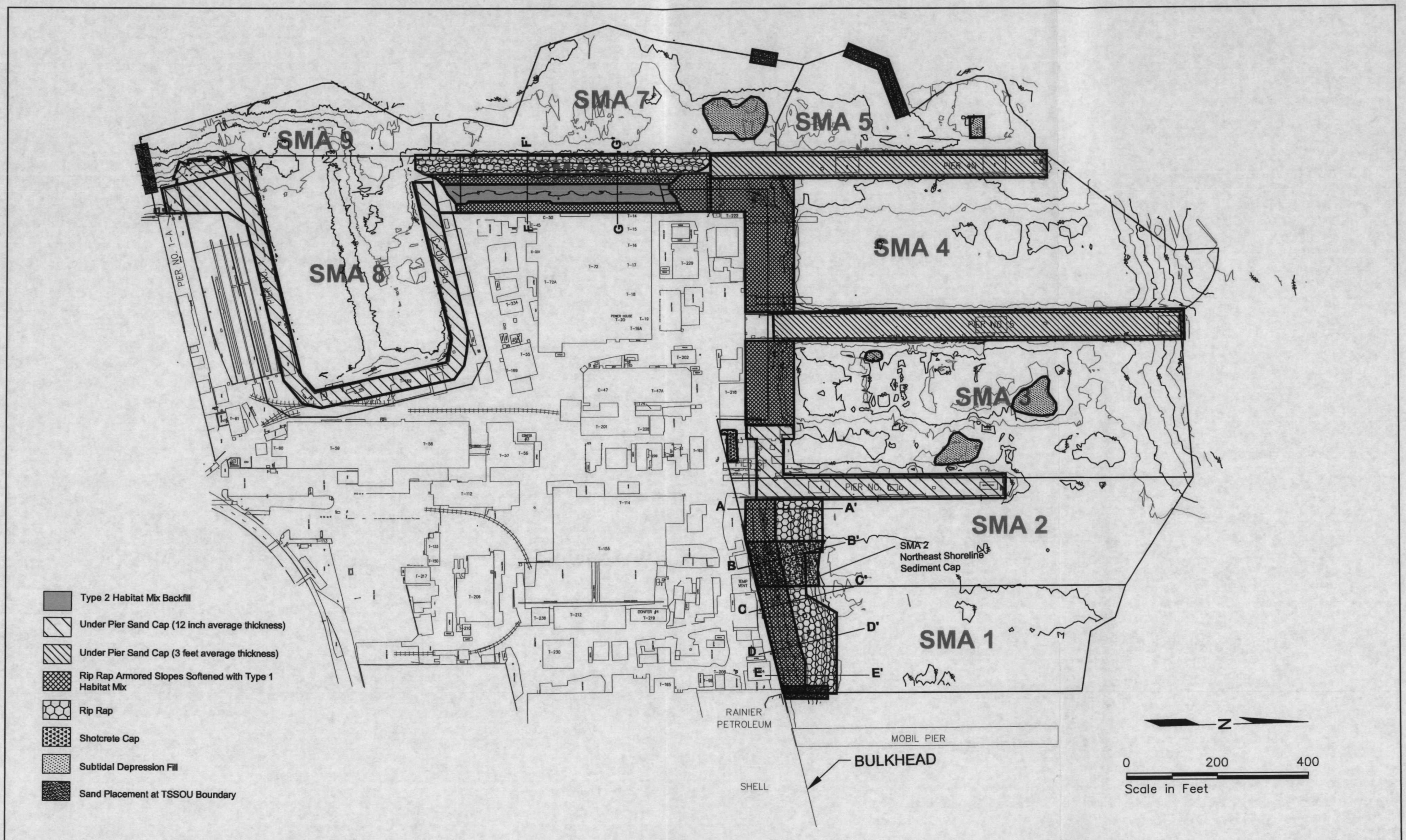


FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 3.1
Final Surface Sediment Verification Stations

DATE: 3/15/2006 5:28:55 PM
MXD NAME: \\Sam\Data\projects\TODD-NPL\GIS\RACR - Figure 3.1 Sedi Verif Stns.mxd

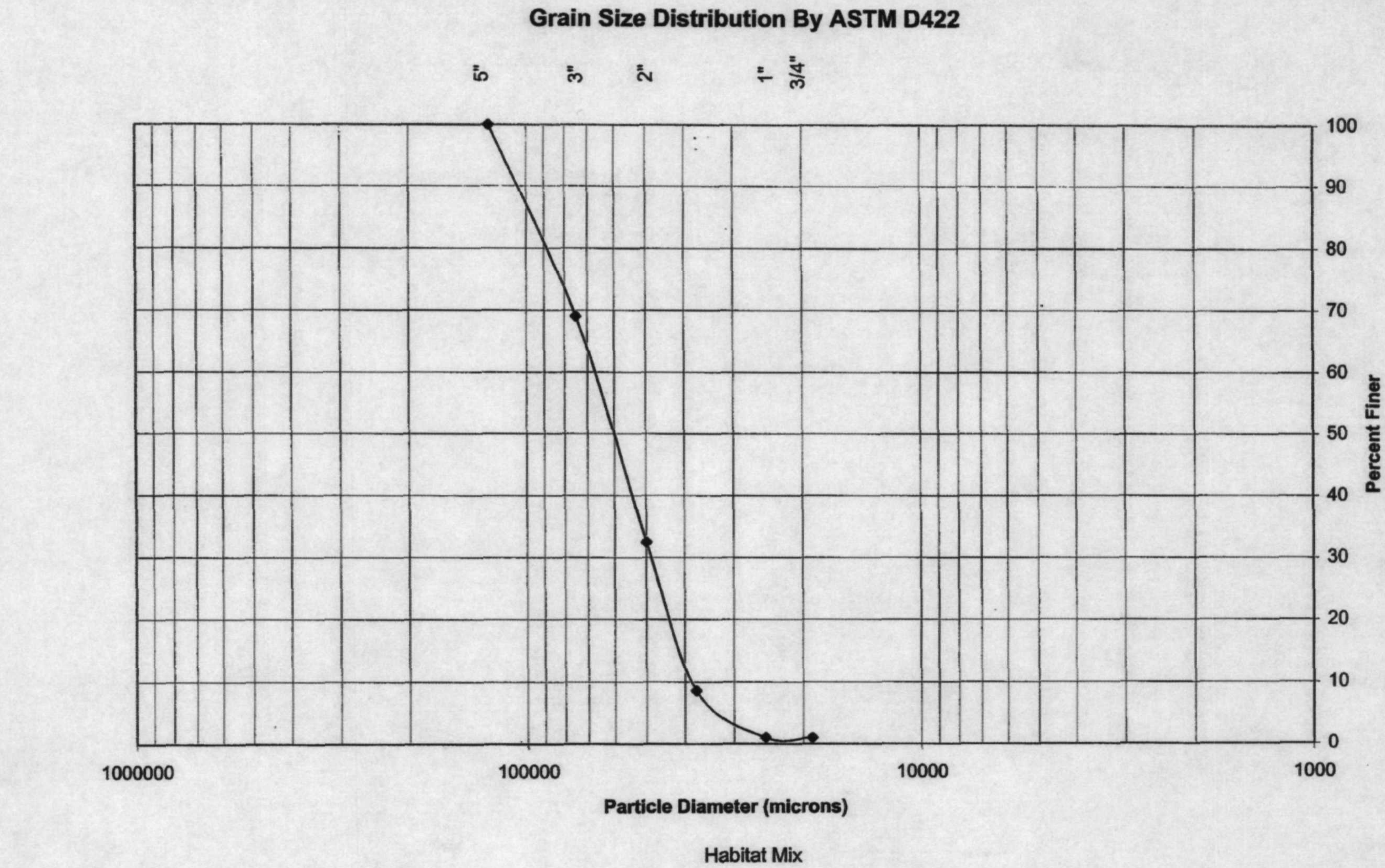


FLOYD | SNIDER
strategy • science • engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

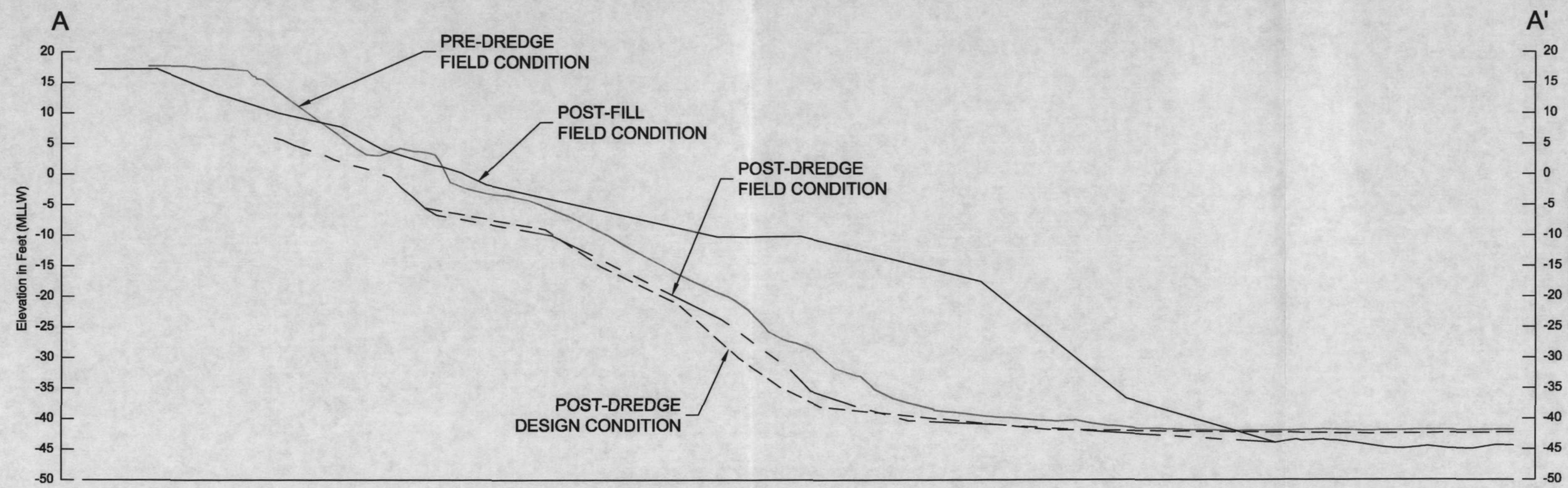
Figure 3.2
Capping and Filling Plan

DWG NAME: G:\project\Clients\Floyd and Snider\todd\technical\todd0162.dwg
DATE: 06/28/07 1:39pm

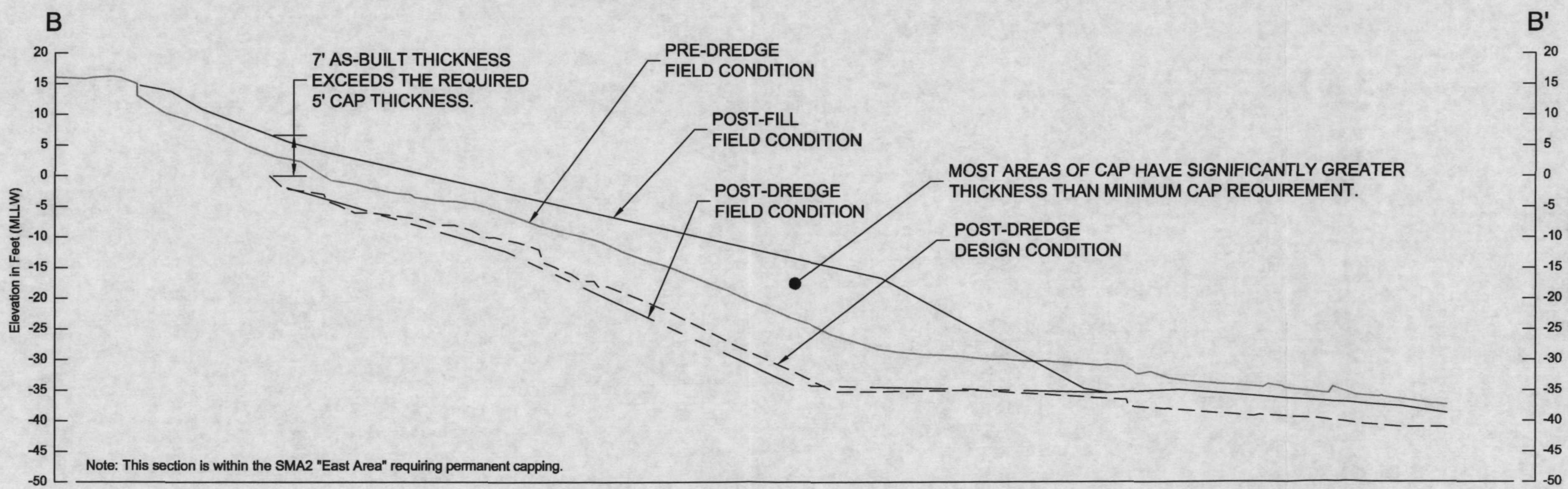


Source: Analytical Resources Incorporated

FLOYD | SNIDER strategy ▪ science ▪ engineering	**Remedial Action Completion Report** **Todd Shipyards** **Sediment Operable Unit**	Figure 3.3 Type 2 Habitat Mix Grain-size Distribution



SECTION A-A' - NORTHEAST SHORELINE (SMA 2)



SECTION B-B' - NORTHEAST SHORELINE (SMA 2)

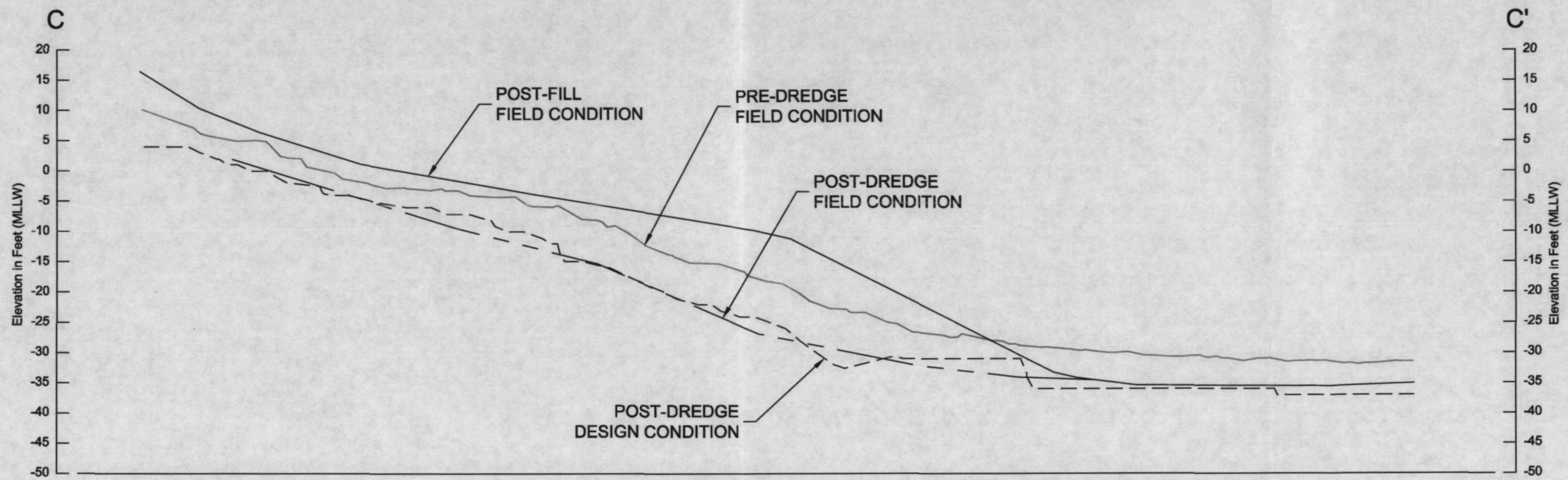
0 20 40
Scale in Feet

FLOYD | SNIDER
strategy ▪ science ▪ engineering

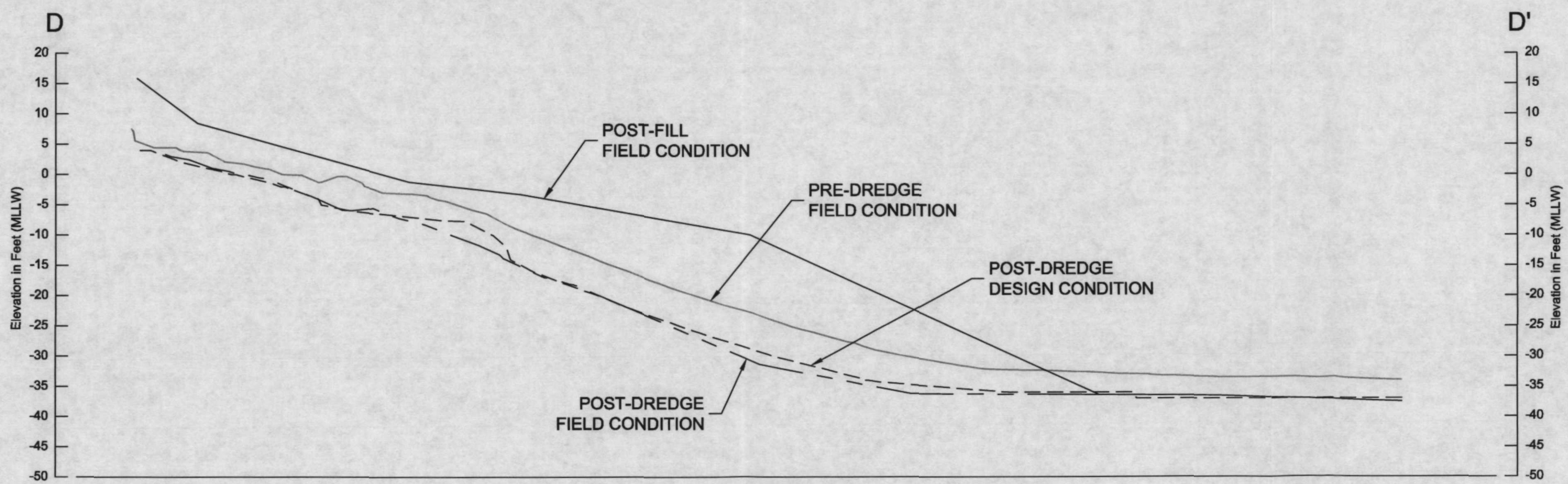
Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 4.1a
Northeast Shoreline Fill Sections

DWG NAME: G:\project\Clients\Floyd and Snider\todd\technical\todd0140 (NEShore Sec Mar2005).dwg
DATE: 03/16/06 08:33am



SECTION C-C' - NORTHEAST SHORELINE (SMA 1)



SECTION D-D' - NORTHEAST SHORELINE (SMA 1)

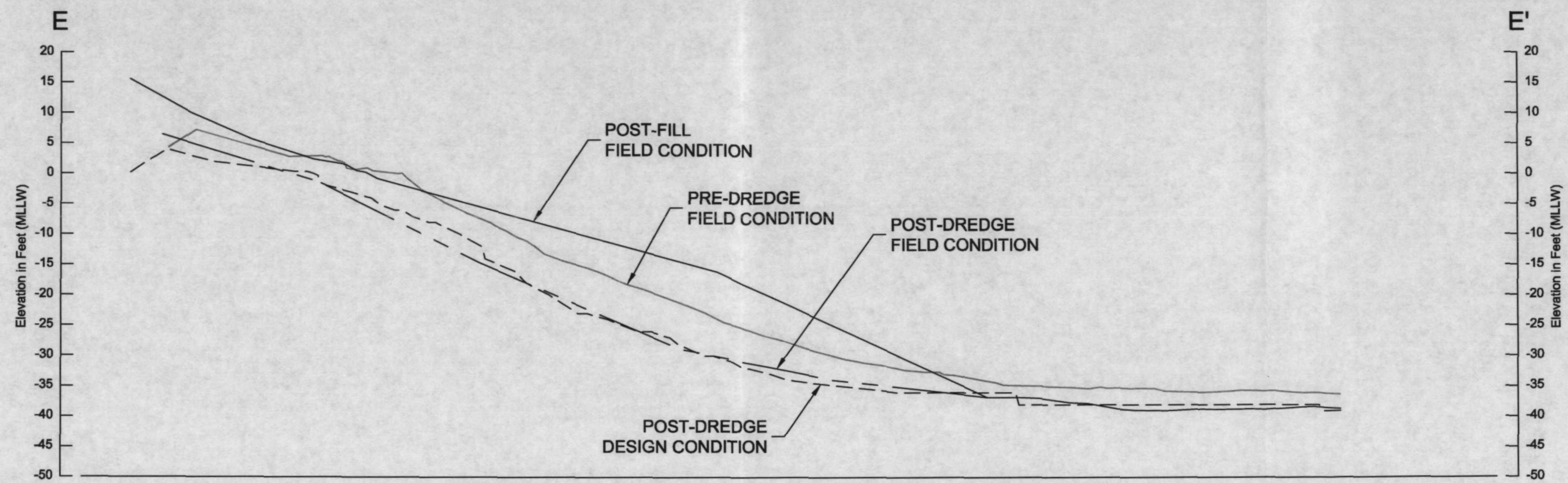
0 20 40
Scale in Feet

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 4.1b
Northeast Shoreline Fill Sections

DWG NAME: G:\project\Clients\Floyd and Snider\todd\technical\todd0140 (NEShore Sec Mar2005).dwg
DATE: 03/16/06 08:33am



SECTION E-E' - NORTHEAST SHORELINE (SMA 1)

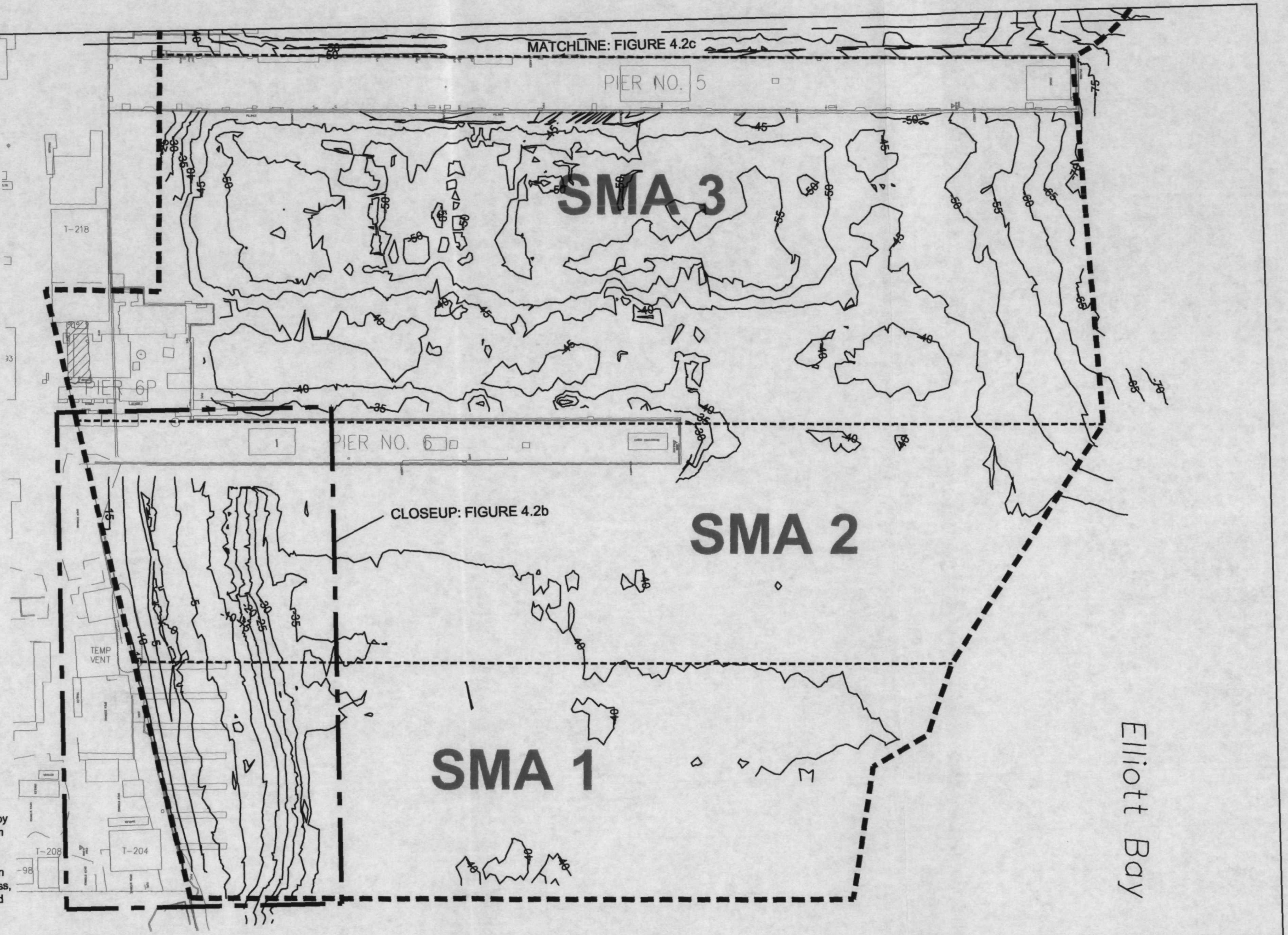
0 20 40
Scale in Feet

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 4.1c
Northeast Shoreline Fill Section

DWG NAME: G:\project\Clients\Floyd and Snider\todd\technical\todd0140 (NEShore Sec Mar2005).dwg
DATE: 03/16/06 08:33am



Notes:

1. Horizontal position and depth data was obtained by General Construction Company using single beam survey and global positioning system (GPS) equipment. Elevations are in feet, referenced to Mean Lower Low Water (MLLW). This information was determined as part of the construction process, not by a licensed professional surveyor or certified hydrographer.

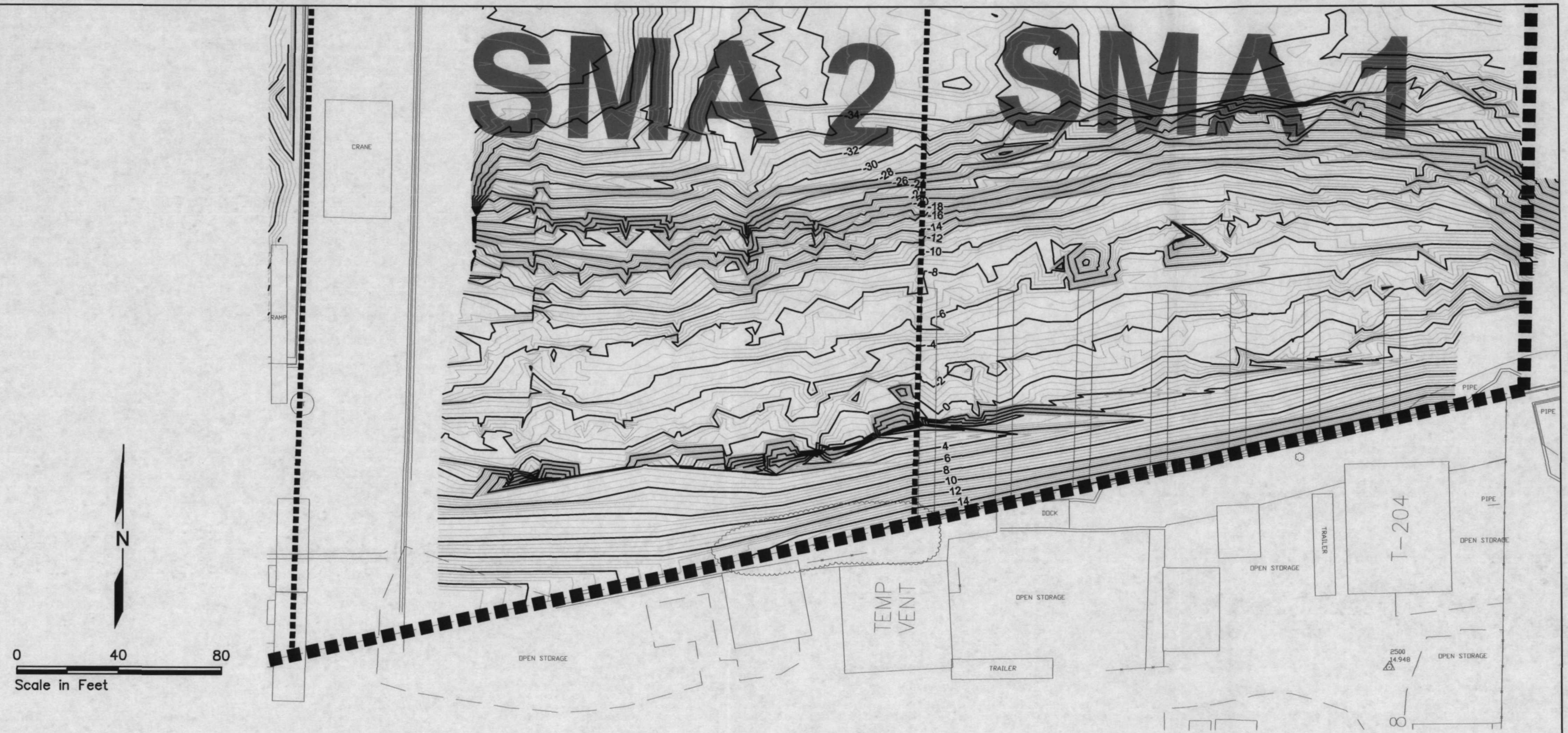
Base Map Source: Walker Associates, 2002 and 2003.

FLOYD | SNIDER
strategy • science • engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 4.2a
Post-remediation Site Bathymetry

DWG NAME: G:\project\Clients\Floyd and Snider\todd\technical\todd0181.dwg
DATE: 07/20/07 10:51am



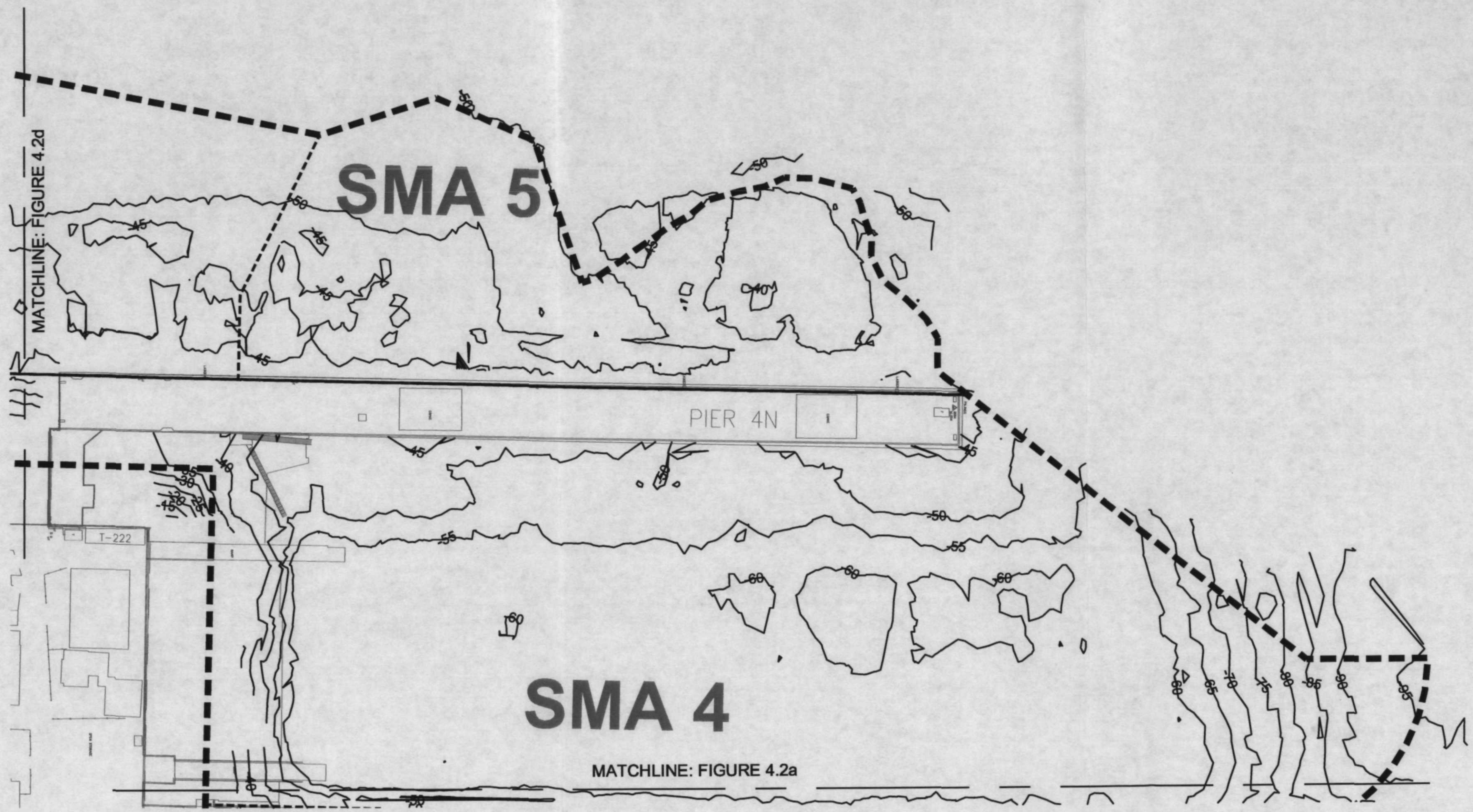
Notes:

1. Horizontal position and depth data was obtained by General Construction Company using single beam survey and global positioning system (GPS) equipment. Elevations are in feet, referenced to Mean Lower Low Water (MLLW). This information was determined as part of the construction process, not by a licensed professional surveyor or certified hydrographer.

Base Map Source: Walker Associates, 2002 and 2003.

FLOYD | SNIDER strategy ▪ science ▪ engineering	**Remedial Action Completion Report** **Todd Shipyards** **Sediment Operable Unit**	Figure 4.2b Post-remediation Site Bathymetry

DWG NAME: G:\project\Clients\Floyd and Snider\todd\technical\todd0163.dwg
DATE: 07/20/07 10:52am



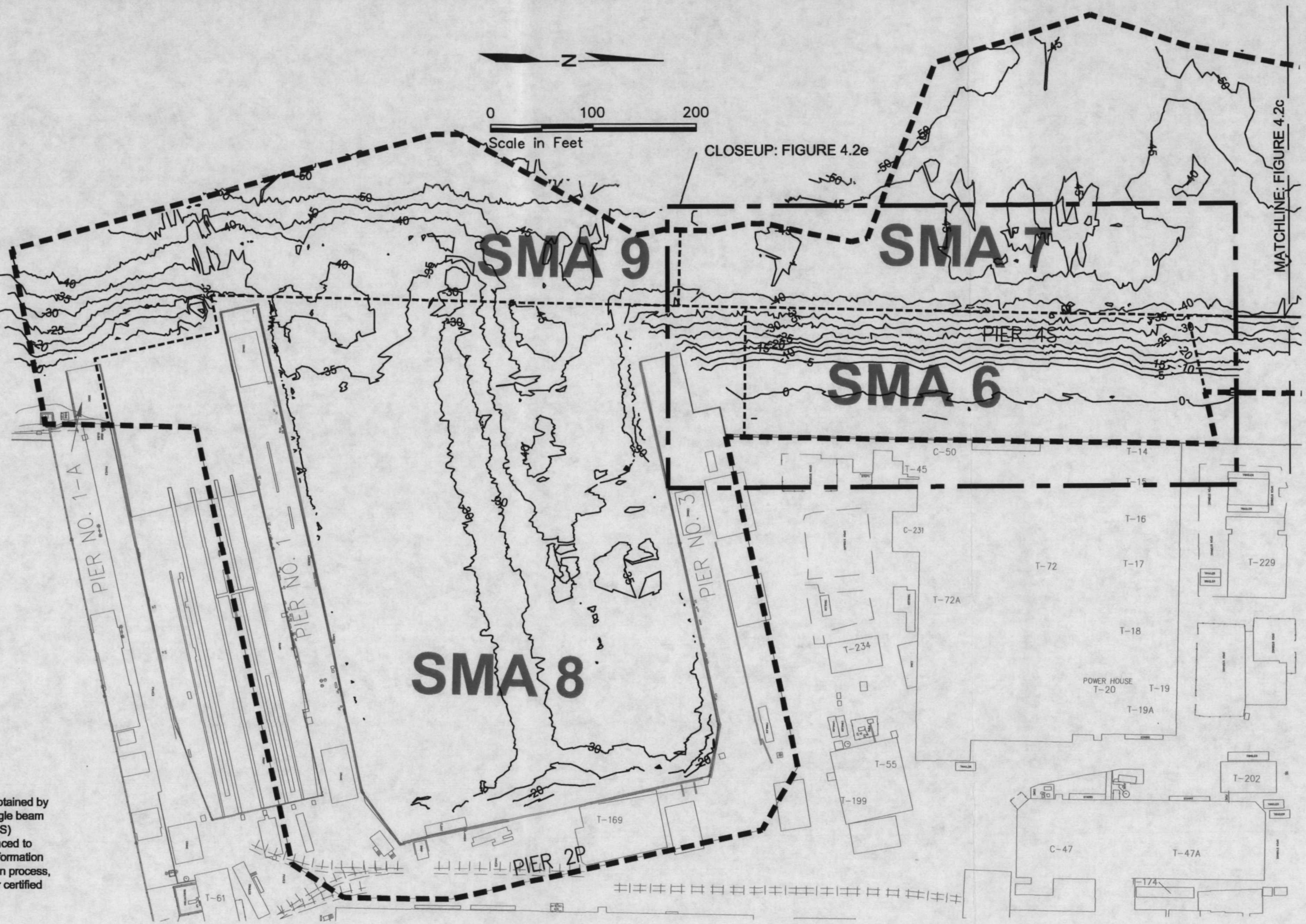
Notes:

1. Horizontal position and depth data was obtained by General Construction Company using single beam survey and global positioning system (GPS) equipment. Elevations are in feet, referenced to Mean Lower Low Water (MLLW). This information was determined as part of the construction process, not by a licensed professional surveyor or certified hydrographer.

Base Map Source: Walker Associates, 2002 and 2003.

FLOYD | SNIDER strategy ▪ science ▪ engineering	**Remedial Action Completion Report** **Todd Shipyards** **Sediment Operable Unit**	Figure 4.2c Post-remediation Site Bathymetry

DWG NAME: G:\project\Clients\Floyd and Snider\todd\technical\todd0161.dwg
DATE: 07/20/07 10:51am



Notes:

1. Horizontal position and depth data was obtained by General Construction Company using single beam survey and global positioning system (GPS) equipment. Elevations are in feet, referenced to Mean Lower Low Water (MLLW). This information was determined as part of the construction process, not by a licensed professional surveyor or certified hydrographer.

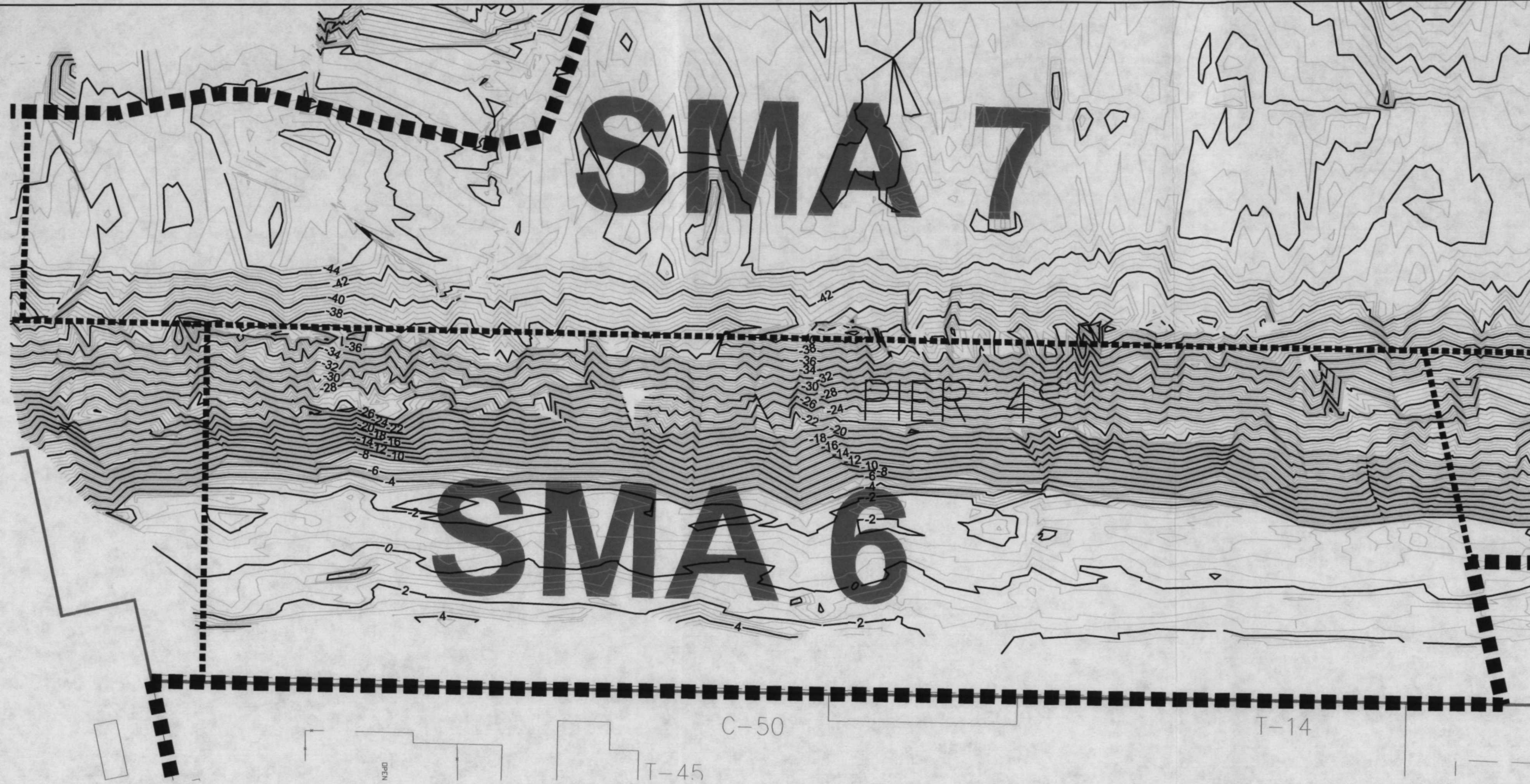
Base Map Source: Walker Associates, 2002 and 2003.

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 4.2d
Post-remediation Site Bathymetry

DWG NAME: G:\project\Clients\Floyd and Snider\todd\technical\todd0161.dwg
DATE: 07/20/07 10:51am



Notes:

1. Horizontal position and depth data was obtained by General Construction Company using single beam survey and global positioning system (GPS) equipment. Elevations are in feet, referenced to Mean Lower Low Water (MLLW). This information was determined as part of the construction process, not by a licensed professional surveyor or certified hydrographer.

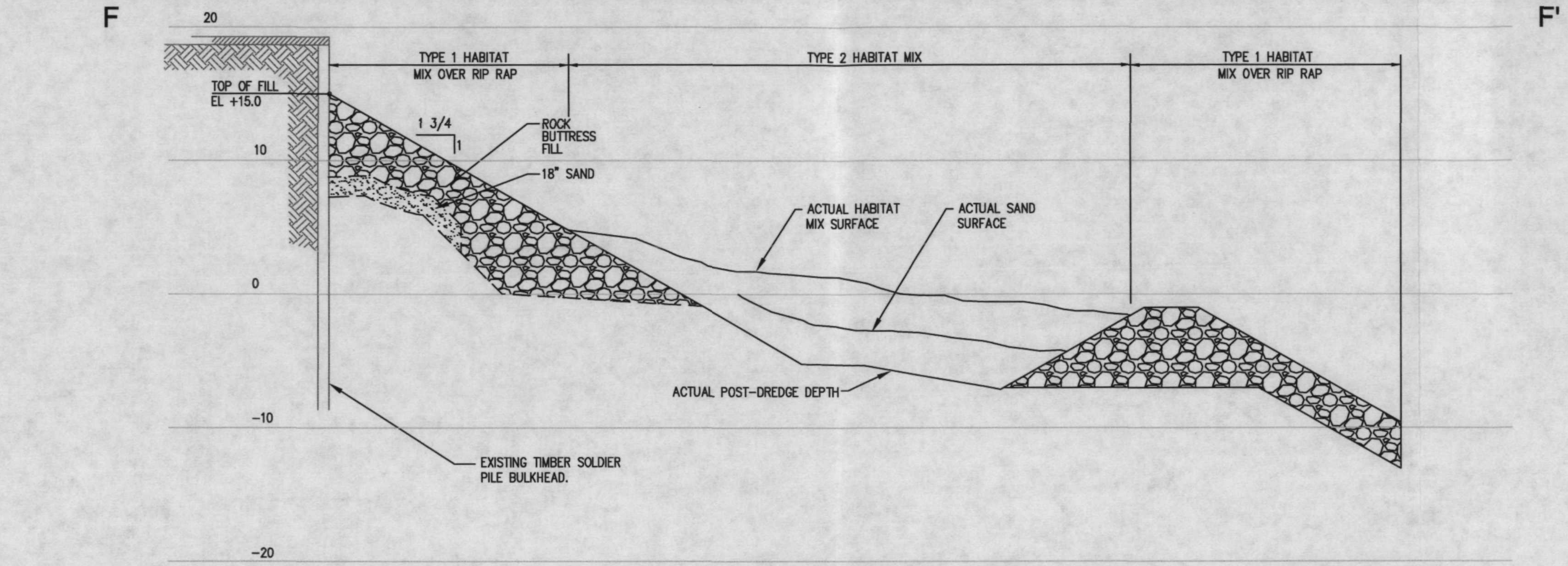
Base Map Source: Walker Associates, 2002 and 2003.

FLOYD | SNIDER
strategy ▪ science ▪ engineering

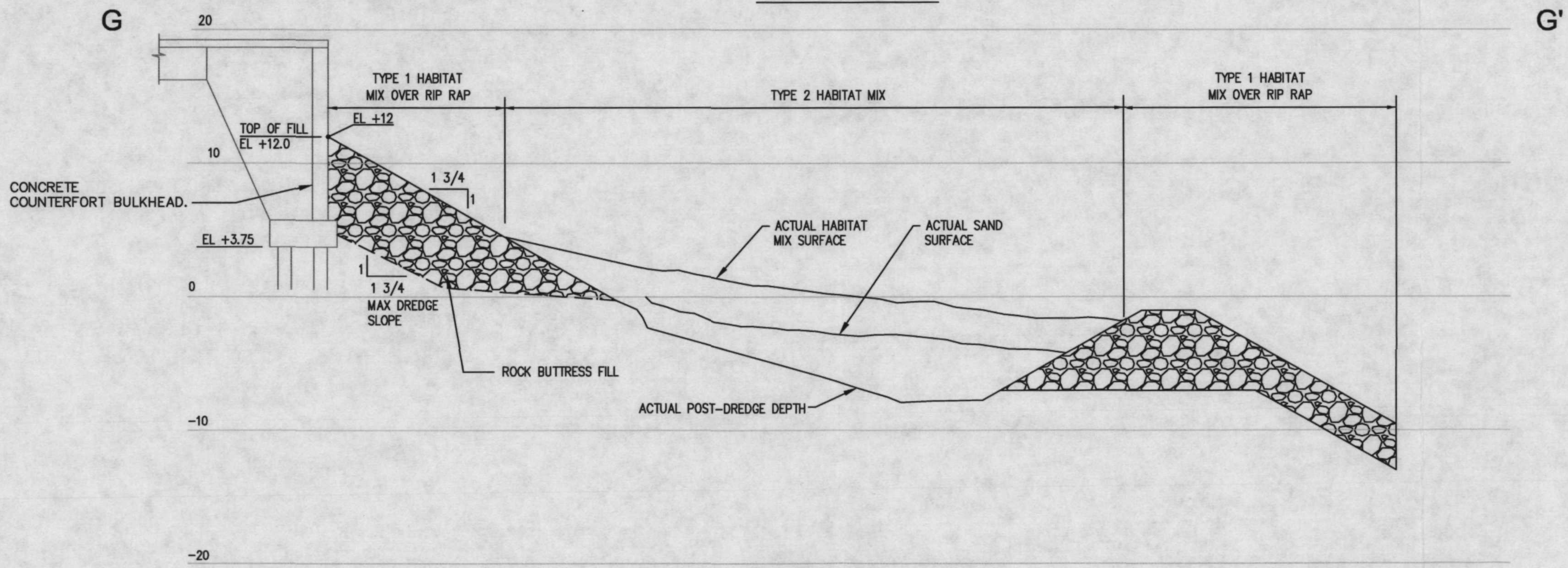
Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 4.2e
Post-remediation Site Bathymetry

DWG NAME: G:\project\Clients\Floyd and Snider\todd\technical\todd0163.dwg
DATE: 07/12/07 09:34am



SECTION F-F'



SECTION G-G'

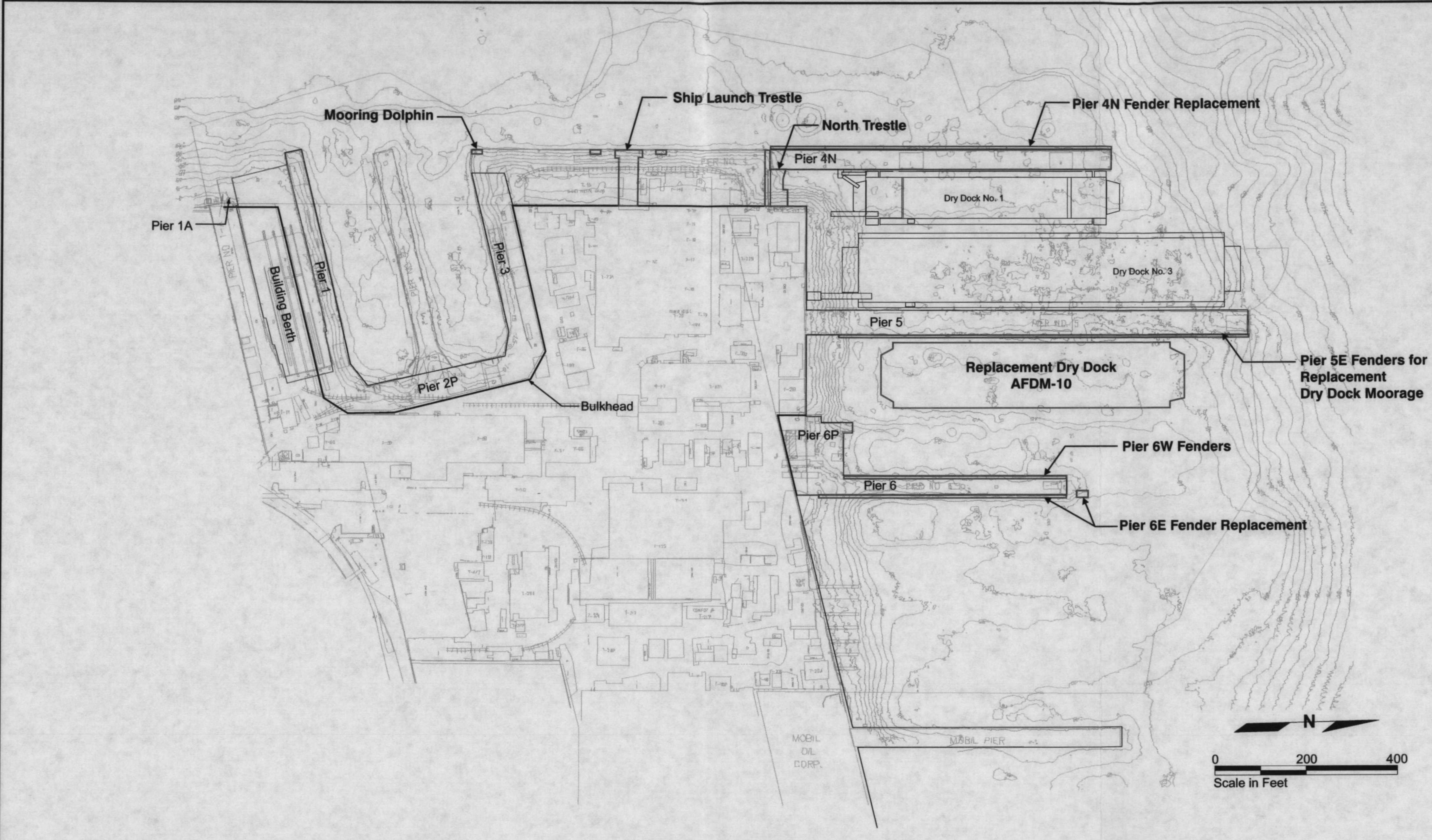
0 10 20
Scale in Feet

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 4.3
SMA 6 Habitat Bench Cross-sections

DWG NAME: G:\project\Clients\Floyd and Snider\todd\technical\todd0151 (SMA6 POST-DREDGE SECTIONS).dwg
DATE: 03/23/06 12:07pm

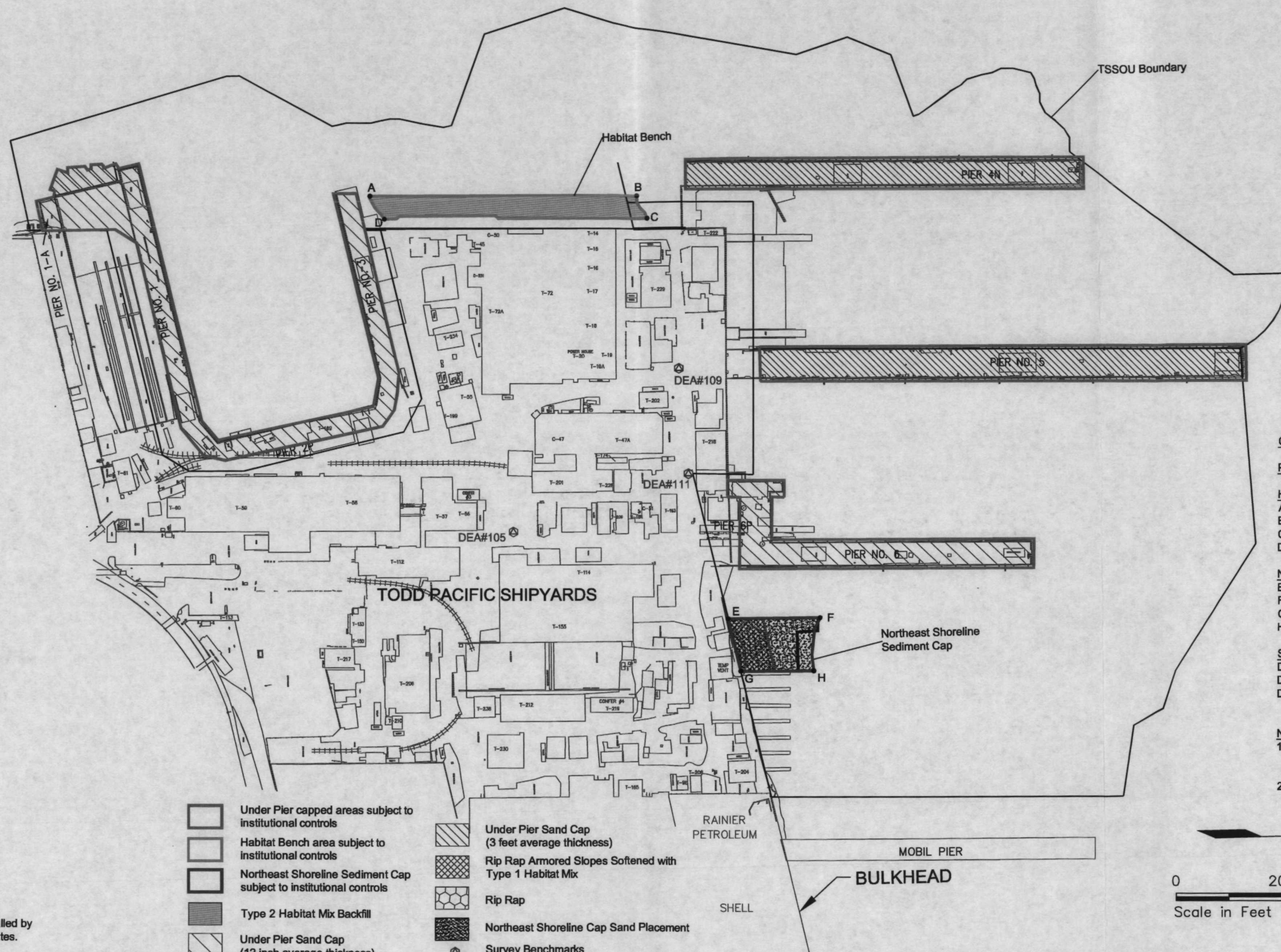


FloydSnider/todd/NewCorelFigures/RemedialActionReport2006/Figure4.4.cdr

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 4.4
Replacement Over-water Structures



COORDINATES

Point No.	Northing	Easting
Habitat Bench		
A	217125.5	1264140.6
B	217625.4	1264150.9
C	217643.8	1264194.2
D	217151.3	1264184.5
Northeast Shoreline Sediment Cap		
E	217777.5	1264953.5
F	217949.9	1264956.1
G	217798.9	1265053.2
H	217935.8	1265055.6
Survey Benchmarks		
DEA#105	217378.15	1264779.96
DEA#109	217696.71	1264479.48
DEA#111	217709.85	1264678.52

Notes:
1. Limits of under-pier capped areas are defined by extent of existing pier structures.
2. Horizontal Datum: NAD 83.

N

0 200 400
Scale in Feet

FLOYD | SNIDER
strategy ▪ science ▪ engineering

KATHRYN H. SNIDER
STATE OF WASHINGTON
REGISTERED
PROFESSIONAL ENGINEER

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 5.1
Institutional Controls Plan

DWG NAME: G:\project\clients\Floyd and Snider\todd\technical\todd0165.dwg
DATE: 07/31/07 3:54pm

SURVEY NOTES

1. PURPOSE OF THIS DRAWING: TO GRAPHICALLY DEPICT THE LOCATIONS OF DAVID EVANS AND ASSOCIATES, INC. SURVEY CONTROL THAT HAS BEEN ESTABLISHED AT TODD SHIPYARD. NOTE: THE CURRENT CONDITION OF SHOWN CONTROL HAS NOT BEEN VERIFIED.

2. DATES OF SURVEY FROM SEPTEMBER 2002, TO JANUARY 2006.

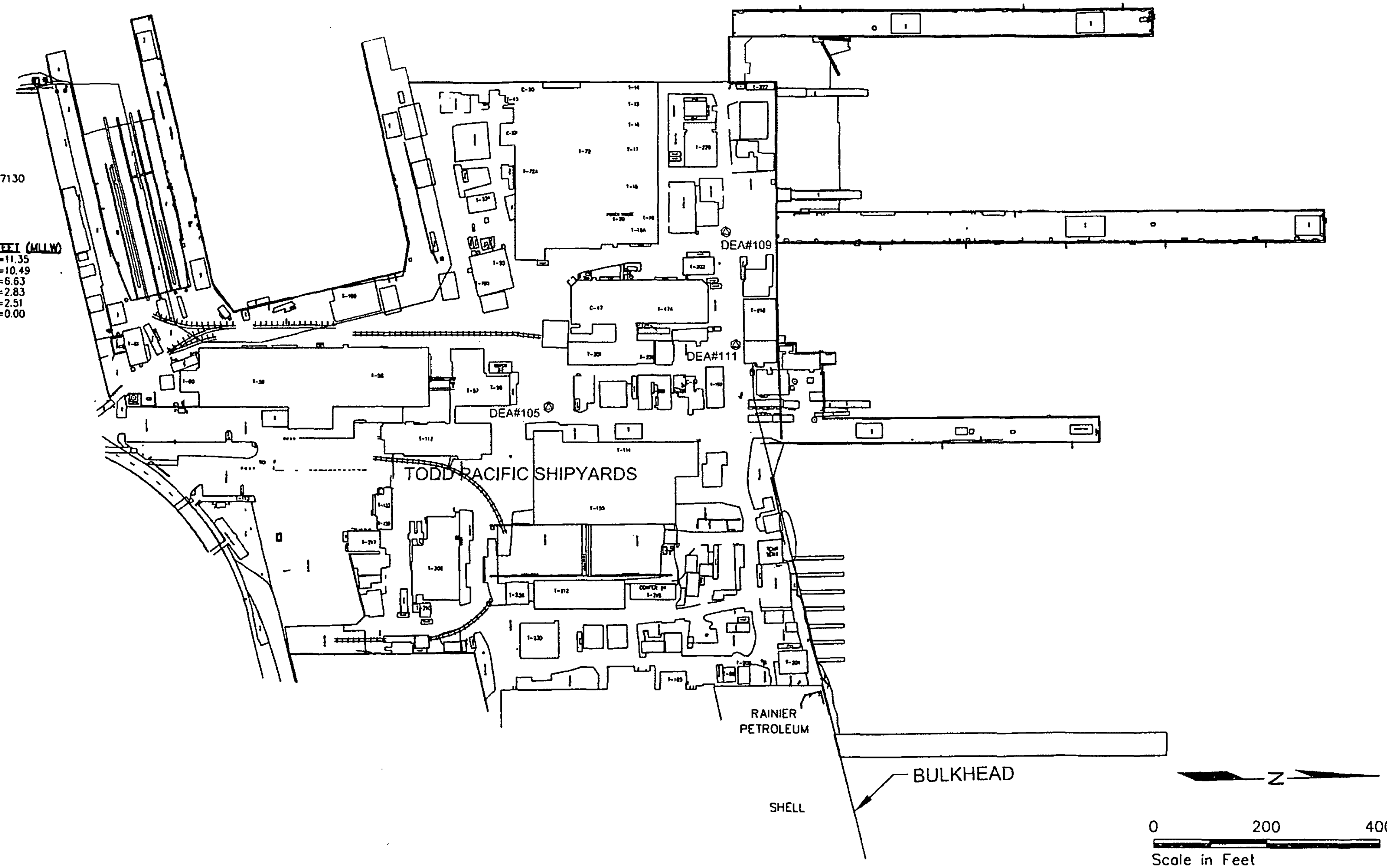
3. HORIZONTAL DATUM NORTH AMERICAN DATUM 1983-91 ADJUSTMENT (NAD83/91), STATE PLANE COORDINATE SYSTEM (SPCS), WASHINGTON NORTH ZONE.

4. VERTICAL DATUM MEAN LOWER LOW WATER (MLLW).

5. SITE MAP BACKGROUND MAP AND FEATURES WERE PROVIDED BY OTHERS AND ARE SHOWN FOR REFERENCE ONLY.

TIDAL DATUMS FOR NOAA STATION 9447130
PUGET SOUND, SEATTLE, WA
LENGTH OF SERIES: 19 YEARS
TIME PERIOD: 1960-1978
TIDAL EPOCH: 1960-1978

DATUM PLANE	EL. IN FEET (MLLW)
MEAN HIGHER HIGH WATER (MHHW)	=11.35
MEAN HIGH WATER (MHW)	=10.49
MEAN SEA LEVEL (MSL)	=6.63
MEAN LOW WATER (MLW)	=2.83
NORTH AMERICAN VERTICAL DATUM - 1988 (NAVD)	=2.51
MEAN LOWER LOW WATER (MLLW)	=0.00

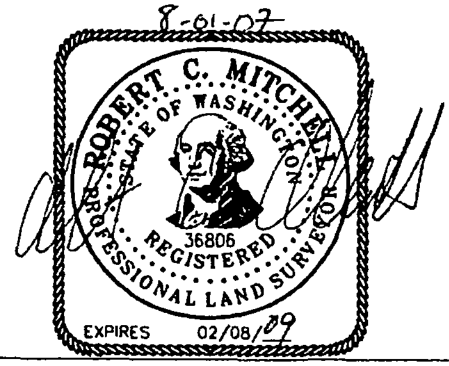


Survey Benchmarks

SURVEY BENCHMARK COORDINATES

Point No.	Northing	Easting
DEA#105	217378.15	1264779.96
DEA#109	217696.71	1264479.48
DEA#111	217709.85	1264678.52

8-01-07



FLOYD | SNIDER
strategy • science • engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure 5.2
Survey Benchmarks

DWG NAME: C:\TEMP\TODD\SurveyBenchmarks.dwg
DATE: 07/31/07 4:03pm

Appendix A/B

Remedial Action Completion Report

Todd Shipyards
Sediment Operable Unit

Appendix A
Quality Assurance Documentation on CD-ROM

Daily Summary Reports
Daily Water Quality Monitoring Reports
Certificates of Disposal for Contaminated Sediment
Core Logs of Final Sediment Samples
Laboratory Analysis of Final Progress Sediment Samples
Laboratory Analysis of In-water Fill and Cap Materials
Laboratory Report of Sediment Toxicity Testing
Under-pier Cap Dive Surveys
Project Meeting Notes

FINAL

Remedial Action Completion Report

Todd Shipyards
Sediment Operable Unit

Appendix B
Construction Drawings, Specifications, and Construction Change Directives on CD-ROM

FINAL

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 SIXTH AVENUE
SEATTLE, WA 98101

TARGET SHEET

The following document was not imaged.
This is due to the Original being:

	Oversized
XX	CD Rom
	Computer Disk
	Video Tape
	Other:

**A copy of the document may be requested from the Superfund Records Center.

Document Information

Document ID #:	1273422
File #:	6.7
Site Name:	Harbor Island

Remedial Action Completion Report.
Appendix A Quality Assurance Documentation

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 SIXTH AVENUE
SEATTLE, WA 98101

TARGET SHEET

The following document was not imaged.
This is due to the Original being:

	Oversized
XX	CD Rom
	Computer Disk
	Video Tape
	Other:

**A copy of the document may be requested from the Superfund Records Center.

Document Information

Document ID #:	1273422
File #:	6.7
Site Name:	Harbor Island

Remedial Action Completion Report.
Appendix B

Appendix C

Remedial Action Completion Report

Todd Shipyards
Sediment Operable Unit

Appendix C
Fish Monitoring Plans and Monitoring Results

FINAL

FLOYD | SNIDER
strategy • science • engineering

83 South King Street, Suite 614
Seattle, Washington 98104
tel: 206.292.2078 fax: 206.682.7867

Technical Memorandum

To: Lynda Priddy, USEPA

Copies:

From: Kate Snider and Jane Fisher

Date: February 1, 2005

Project No: Todd.NPL.4020

Re: **Fish Monitoring Plan**
Todd Shipyards Sediment Operable Unit

Introduction

This technical memorandum presents the Fish Monitoring Plan that will be implemented during Remedial Action construction in the Todd Shipyards Sediment Operable Unit (TSSOU) to evaluate potential impacts to juvenile Chinook salmon and bull trout during dredging outside the in-water construction window from February 15 to March 1, 2005. This plan is based on a tiered approach and is similar to the Fish Monitoring Plan developed for the East Waterway (EWW) by the Port of Seattle in 2004 but has been modified to be specific to the West Waterway and the TSSOU.

Level 1 Monitoring – Initial Fish Monitoring at the Duwamish Turning Basin

Level 1 Monitoring will consist of weekly beach seine monitoring at the Turning Basin in the Duwamish River (river mile 5), beginning the first week of February, upstream of the dredging activity within the TSSOU. This monitoring will evaluate the presence and abundance of juvenile Chinook salmon migrating downstream. The purpose of this monitoring is to provide an indication of the migration timing of juvenile Chinook salmon into the Duwamish River and ultimately into the West Waterway. Level 2 Monitoring would be initiated if a criterion of 100 juvenile Chinook/seine (as an average catch of three beach seines in a day) is exceeded, which is based on past monitoring conducted at the Turning Basin in February and March of 2003 per the EWW Fish Monitoring Plan. Todd will notify participating regulatory agencies (USEPA, NOAA, USFWS, and WDFW) of the Level 1 Monitoring results prior to moving forward with Level 2 monitoring activities.

Level 2 Monitoring – Initiate Fish Monitoring in the West Waterway

Starting on February 15, 2005 or earlier if the Level 1 criterion is exceeded during Level 1 Monitoring, beach seine monitoring will be initiated at two additional locations in the West Waterway: near the head of the waterway at the Port of Seattle public access beach just south of Fisher Flour and at the Lockheed beach site just upstream of the dredging activity. A monitoring station is proposed for just upstream of the TSSOU due to the 2:1 or greater riprap slopes and over-water structures present at the site. Level 2 Monitoring will be conducted twice a week in conjunction with the continued monitoring at the Turning Basin. Level 3 Monitoring would be initiated if a criterion of three Chinook salmon or bull trout (as an average catch of three beach seines in a day) is exceeded at either location, which is based on past monitoring conducted at Slip 27 in February and March of 2003 in the absence of other recommended criteria for the West Waterway. Todd will notify participating regulatory agencies of the Level 2 Monitoring results prior to moving forward with Level 3 monitoring activities.

Level 3 Monitoring - Initiate Daily Fish Monitoring in the West Waterway and Initiate Project Impact Reduction Planning

If the Level 2 criterion is exceeded during Level 2 Monitoring at either of the two stations in the West Waterway, beach seining will continue for two successive days at each of the sites to confirm the presence of juvenile Chinook salmon and/or bull trout. During this time, Todd will contact the participating regulatory agencies to inform them of the fish monitoring results and water quality monitoring conducted by Todd during dredging.

If the Level 2 criterion is exceeded during the additional 2 days of daily sampling at either West Waterway monitoring locations, BMPs and additional monitoring will be implemented during the dredging operation to minimize and evaluate potential impacts to juvenile fish. BMPs that will be implemented are dependant upon the location of the Remedial Action construction activities. Remedial Action construction activities that may potentially be conducted during the February 1 to March 1, 2005 time period and the associated BMPs and additional monitoring that will be implemented are as follows:

1. Re-dredging in deep water on the north, Elliott Bay side of the site (SMA 3, about 400' east of the West Waterway) and possibly filling deep (approximately 40' deep) subtidal depressions with clean sand in this same general area;

   This area is not anticipated to be a sensitive area for juvenile Chinook and bull trout due the location relative to the West Waterway and presence of floating drydocks that may act as a barrier; however, a qualified biologist will be on site observing the construction activities for the first two days for the presence of these fish. These observations will be reported back to the agencies to facilitate evaluation of potential impacts and determination of appropriate BMPs to be implemented in the future.

2. Re-dredging in deep water in SMA 5 in the West Waterway just west of Pier 4 north and dredging in the big slip adjacent to but off the main channel of the West Waterway (SMA 8):

   A boom with 6' curtain will be used to help to direct juveniles around the work area. In addition, a qualified biologist will be on site observing the construction activities for the first two days for the presence of these fish and the effectiveness of BMPs. These observations will be reported back to the agencies to facilitate evaluation of potential impacts and determination of upgrades to BMPs to be implemented in the future.

TAYLOR ASSOCIATES, INC.

MEMORANDUM

TO:	Jane Fisher, Floyd Snider
FROM:	Jim Shannon, Taylor Associates, Inc.
DATE:	April 4, 2005
RE:	Todd Shipyards Sediment Operable Unit Fish Monitoring Technical Memorandum

This technical memorandum summarizes Taylor Associates, Inc. (TAI) Todd Shipyards Sediment Operable Unit (TSSOU) Fish Monitoring project which was conducted on the Duwamish River, WA.

Because dredging at the TSSOU, located in the West Waterway (WWW) of the Duwamish River was conducted outside of the currently accepted construction window, fish monitoring was implemented to minimize take of Endangered Species Act (ESA) listed fish species. TAI staff beach seined for the presence and abundance of Chinook salmon (*Oncorhynchus tshawytcha*) and bull trout (*Salvelinus confluentus*) at the Turning Basin and WWW starting February 1 through February 24, 2005.

Chinook salmon were present in the WWW (n=1) but did not exceed threshold conditions necessary to implement additional minimization measures. During the monitoring period, TAI captured no bull trout. Based on these results, incidental take (harm or harass) from the project to bull trout was none and very minimal to juvenile Chinook salmon.

Introduction
In order to receive an extension of dredging of the TSSOU into the "fish window" regulatory agencies required a fish monitoring plan be put in force. The goal of the fish monitoring plan include:

- Determine the presence/absence and abundance of ESA listed fish species in the WWW an at the Turning Basin (River Mile 5.5)

Methods
The goals of the project were achieved by implementing a beach seining protocol with a tiered approach. The tiers were based on the catch per unit of effort of Chinook salmon and bull trout. The below passage is an excerpt from the original monitoring plan:

Level 1 Monitoring – Initial Fish Monitoring at the Duwamish

7104 Greenwood Ave. N.
Seattle, WA 98103
main (206) 267-1400
fax (206) 267-1401

Consulting in the Coastal and Freshwater Sciences

Turning Basin
Level 1 Monitoring will consist of weekly beach seine monitoring at the Turning Basin in the Duwamish River (river mile 5), beginning the first week of February, upstream of the dredging activity within the TSSOU. This monitoring will evaluate the presence and abundance of juvenile Chinook salmon migrating downstream. The purpose of this monitoring is to provide an indication of the migration timing of juvenile Chinook salmon into the Duwamish River and ultimately into the West Waterway. Level 2 Monitoring would be initiated if a criterion of 100 juvenile Chinook/seine (as an average catch of three beach seines in a day) is exceeded, which is based on past monitoring conducted at the Turning Basin in February and March of 2003 per the EWW Fish Monitoring Plan. Todd will notify participating regulatory agencies (USEPA, NOAA, USFWS, and WDFW) of the Level 1 Monitoring results prior to moving forward with Level 2 monitoring activities.

Level 2 Monitoring – Initiate Fish Monitoring in the West Waterway
Starting on February 15, 2005 or earlier if the Level 1 criterion is exceeded during Level 1 Monitoring, beach seine monitoring will be initiated at two additional locations in the West Waterway: near the head of the waterway at the Port of Seattle public access beach just south of Fisher Flour and at the Lockheed beach site just upstream of the dredging activity. A monitoring station is proposed for just upstream of the TSSOU due to the 2:1 or greater riprap slopes and over-water structures present at the site. Level 2 Monitoring will be conducted twice a week in conjunction with the continued monitoring at the Turning Basin. Level 3 Monitoring would be initiated if a criterion of three Chinook salmon or bull trout (as an average catch of three beach seines in a day) is exceeded at either location, which is based on past monitoring conducted at Slip 27 in February and March of 2003 in the absence of other recommended criteria for the West Waterway. Todd will notify participating regulatory agencies of the Level 2 Monitoring results prior to moving forward with Level 3 monitoring activities.

Level 3 Monitoring - Initiate Daily Fish Monitoring in the West Waterway and Initiate Project Impact Reduction Planning
If the Level 2 criterion is exceeded during Level 2 Monitoring at either of the two stations in the West Waterway, beach seining will continue for two successive days at each of the sites to confirm the presence of juvenile Chinook salmon and/or bull trout. During this time, Todd will contact the participating regulatory agencies to inform them of the fish monitoring results and water quality monitoring conducted by Todd during dredging. If the Level 2 criterion is exceeded during the additional 2 days of daily sampling at either West Waterway monitoring locations, BMPs

and additional monitoring will be implemented during the dredging operation to minimize and evaluate potential impacts to juvenile fish. BMPs that will be implemented are dependant upon the location of the Remedial Action construction activities. Remedial Action construction activities that may potentially be conducted during the February 1 to March 1, 2005 time period and the associated BMPs and additional monitoring that will be implemented are as follows:

1. Re-dredging in deep water on the north, Elliott Bay side of the site (SMA 3, about 400' east of the West Waterway) and possibly filling deep (approximately 40' deep) subtidal depressions with clean sand in this same general area;

This area is not anticipated to be a sensitive area for juvenile Chinook and bull trout due the location relative to the West Waterway and presence of floating drydocks that may act as a barrier; however, a qualified biologist will be on site observing the construction activities for the first two days for the presence of these fish. These observations will be reported back to the agencies to facilitate evaluation of potential impacts and determination of appropriate BMPs to be implemented in the future.

2. Re-dredging in deep water in SMA 5 in the West Waterway just west of Pier 4 north and dredging in the big slip adjacent to but off the main channel of the West Waterway (SMA 8):

A boom with 6' curtain will be used to help to direct juveniles around the work area. In addition, a qualified biologist will be on site observing the construction activities for the presence of these fish and the effectiveness of BMPs. These observations will be reported back to the agencies to facilitate evaluation of potential impacts and determination of upgrades to BMPs to be implemented in the future.

Our sampling sites included the Turning Basin, Port Park, and Lockheed. The Turning Basin is located at river mile 5.5 on the Duwamish River. This site was used as an indicator for the beginning of the juvenile Chinook salmon outmigration. We conducted three non-overlapping beach seine sets once a week at the Turning Basin.

Port Park and Lockheed are located in the WWW of the Duwamish River (RM 0.0). Port Park is located on the West side of Harbor Island across the waterway form Terminal 5. Lockheed is located on the west side of Harbor Island just north of Port Park. We conducted one set twice per week at each of these sites.

We used a Puget Sound Protocol beach seine set from a 17-foot Boston Whaler to capture fish species. We identified captured fish to species and released all species with care. We also determined if juvenile salmon were of hatchery origin by examining for adipose fin clips. Incidental take coverage for the fish monitoring was provided through two permits: NOAA Fisheries ESA Section 10a1a permit 1314 and USFWS ESA Section 10a1a permit TE034300-1.

Results

Over a total of 6 sampling dates, we conducted 20 beach seine sets at three sites: the Turning Basin, Port Park, and Lockheed (Table 1). We captured

Table 1. Date, location, and number of sets for WWW fish monitoring, winter 2005.

Date	Turning Basin	Port Park	Lockheed	Total
February 1	3	0	0	3
February 8	3	0	0	3
February 15	3	1	1	5
February 18	0	1	1	2
February 21	3	1	1	5
February 24	0	1	1	2
Total	12	4	4	20

juvenile naturally produced (wild) Chinook salmon at the Turning Basin on every day we sampled there. We only captured one juvenile Chinook salmon in the WWW (Lockheed) on February 21, 2005. During the monitoring period, we did not catch bull trout.

Discussion

The discussion section is broken into two parts to represent the two tiers of sampling conducted. In summary, no threshold exceedances occurred during the monitoring periods. Therefore, additional minimization measures were not required.

We did catch juvenile Chinook salmon at the Turning Basin on February 1, 8, 15, and 21. We did not break the threshold of 100 Chinook per seine (Table 2). Therefore, we started sampling in the WWW on February 15.

Table 2. Turning Basin sets, Chinook captured, and CPUE.

Date	# of Sets	# Chinook Captured	Catch per Unit Effort
February 1	3	217	72
February 8	3	95	32
February 15	3	60	20
February 21	3	19	6

Only one juvenile wild Chinook salmon was captured in the WWW during the second tier (Table 3). No bull trout were captured in the WWW.

Table 3. WWW sets, Chinook captured, and CPUE.

Date	# of Sets	# Chinook Captured	Catch per Unit Effort
February 15	2	0	0
February 18	2	0	0
February 21	2	1	0.5
February 24	2	0	0

The one juvenile Chinook salmon captured on February 21st was captured at Lockheed. Lockheed is located in an area under redevelopment and the intertidal zone has recently been enhanced with small gravels and cobbles.

In summary, TAI captured no bull trout in the Turning Basin or WWW during our sampling from February 1 to February 24, 2005. The CPUE threshold for tier 1 and tier 2 sampling was not exceeded.

Site	Actual date	Count of Set	Chinook (wild) 0+	Chinook (wild) 1+	bull trout	Average of Chinook (wild) 0+	Average of Chinook (wild) 1+	Average of bull trout
Lockheed		**4**	**1**	**0**	**0**	**0.25**	**0**	**0**
	2/15/2005	1	0	0	0	0	0	0
	2/18/2005	1	0	0	0	0	0	0
	2/21/2005	1	1	0	0	1	0	0
	2/24/2005	1	0	0	0	0	0	0
Port Park		**4**	**0**	**0**	**0**	**0**	**0**	**0**
	2/15/2005	1	0	0	0	0	0	0
	2/18/2005	1	0	0	0	0	0	0
	2/21/2005	1	0	0	0	0	0	0
	2/24/2005	1	0	0	0	0	0	0
Turning Basin		**12**	**391**	**1**	**0**	**32.58333333**	**0.083333333**	**0**
	2/1/2005	3	217	1	0	72.33333333	0.333333333	0
	2/8/2005	3	95	0	0	31.66666667	0	0
	2/15/2005	3	60	0	0	20	0	0
	2/21/2005	3	19	0	0	6.333333333	0	0
Grand Total		**20**	**392**	**1**	**0**	**19.6**	**0.05**	**0**

FLOYD | SNIDER
strategy • science • engineering
Two Union Square • 601 Union Street • Suite 600
Seattle, Washington 98101 • tel: 206.292.2078 • fax: 206.682.7867

Memorandum

To: Lynda Priddy, EPA
Copies: Al Krum, Todd Shipyards
From: Kate Snider
Date: 1/16/07
Project No: TODD-NPL2
Re: **Todd Shipyards – 2007 Fish Monitoring Plan**

Introduction

Construction of replacement structures is underway at Todd Shipyards as the final element of the Superfund Remedial Action scope for the Todd Shipyard Sediment Operable Unit (TSSOU) of the Harbor Island Superfund Site. This work to replace structures demolished to facilitate sediment cleanup includes installation of fender piling at Piers 5 & 6 on Elliott Bay, and construction of a replacement level-launch facility south of Pier 4 on the West Waterway.

Per the NOAA and USFW Biological Opinions that cover this work, in-water work is planned to be complete by February 15, 2007. However, delivery of a portion of the steel piling necessary for the work has been delayed by the pile manufacturer, due to constraints on the piling fabrication and coating caused by the winter weather. The necessary remaining piling are promised for delivery on February 5. If that date is met, in-water construction can be completed by the February 15 deadline.

As a contingency, Todd Shipyards would like to perform fish monitoring beginning February 1, to support a request for an extension of the in-water construction window to March 1 if necessary. Work that would be completed during the extension would be solely the remaining necessary piling installation.

This technical memorandum presents the proposed Fish Monitoring Plan that will be implemented during Remedial Action construction in the TSSOU to evaluate potential impacts to juvenile Chinook salmon and bull trout during piling installation outside the in-water construction window from February 15 to March 1, 2007. This plan is based on a tiered approach and is identical to the Fish Monitoring Plan approved and implemented at the TSSOU in February 2005.

Level 1 Monitoring – Initial Fish Monitoring at the Duwamish Turning Basin

Level 1 Monitoring will consist of weekly beach seine monitoring at the Turning Basin in the Duwamish River (river mile 5), beginning the first week of February, upstream of the construction activity within the TSSOU. This monitoring will evaluate the presence and abundance of juvenile Chinook salmon migrating downstream. The purpose of this monitoring is to provide an indication of the migration timing of juvenile Chinook salmon into the Duwamish River and ultimately into the West Waterway. Level 2 Monitoring would be initiated if a criterion of 100 juvenile Chinook/seine (as an average catch of three beach seines in a day) is exceeded. Todd will notify participating regulatory agencies (USEPA, NOAA, USFWS, and WDFW) of the Level 1 Monitoring results prior to moving forward with Level 2 monitoring activities.

Level 2 Monitoring – Initiate Fish Monitoring in the West Waterway

Starting on February 15, 2007 or earlier if the Level 1 criterion is exceeded during Level 1 Monitoring, beach seine monitoring will be initiated at two additional locations in the West Waterway: near the head of the waterway at the Port of Seattle public access beach just south of Fisher Flour and at the Lockheed beach site just upstream of the Todd Shipyard property. Level 2 Monitoring will be conducted twice a week in conjunction with the continued monitoring at the Turning Basin. Level 3 Monitoring would be initiated if a criterion of three Chinook salmon or bull trout (as an average catch of three beach seines in a day) is exceeded at either location. Todd will notify participating regulatory agencies of the Level 2 Monitoring results prior to moving forward with Level 3 monitoring activities.

Level 3 Monitoring - Initiate Daily Fish Monitoring in the West Waterway and Initiate Project Impact Reduction Planning

If the Level 2 criterion is exceeded during Level 2 Monitoring at either of the two stations in the West Waterway, beach seining will continue for two successive days at each of the sites to confirm the presence of juvenile Chinook salmon and/or bull trout. During this time, Todd will contact the participating regulatory agencies to inform them of the fish monitoring results.

If the Level 2 criterion is exceeded during the additional 2 days of daily sampling at either West Waterway monitoring locations, BMPs and additional monitoring will be implemented during the piling installation operation to minimize and evaluate potential impacts to juvenile fish. BMPs that will be implemented are dependant upon the location of the construction activities. Construction activities that may potentially be conducted during the February 15 to March 1, 2007 time period and the associated BMPs and additional monitoring that will be implemented are as follows:

1. Steel piling installation with vibratory hammer at Pier 6 on the north, Elliott Bay side of the site.

   This area is not anticipated to be a sensitive area for juvenile Chinook and bull trout due the location relative to the West Waterway and presence of floating drydocks that may act as a barrier; however, a qualified biologist will be on site observing the construction activities for the first two days after Level 2 criterion is exceeded for the presence of these fish. These observations will be reported back to the agencies to facilitate evaluation of potential impacts and determination of appropriate BMPs to be implemented.

2. Steel piling installation with impact hammer for the replacement level launch facility south of Pier 4 on the West Waterway.

   A bubble curtain will be used during all piling installation in this area, as an impact hammer will be used for installation. If Level 2 criterion are exceeded, a boom with 6' curtain will be deployed to help to direct juveniles around the work area. In addition, a qualified biologist will be on site observing the construction activities for the first two days for the presence of these fish and the effectiveness of BMPs. These observations will be reported back to the agencies to facilitate evaluation of potential impacts and determination of upgrades to BMPs to be implemented.

TAYLOR
ASSOCIATES, INC.

MEMORANDUM

TO:	Stephen Bentsen (Floyd Snider)
FROM:	Peter Heltzel (Taylor Associates, Inc.)
DATE:	March 7th, 2007
RE:	FINAL – Todd Shipyards Sediment Operable Unit Fish Monitoring Technical Memorandum

This technical memorandum summarizes fish monitoring activities by Taylor Associates, Inc. (TAI) on the Duwamish River during February 2007. Fish monitoring was conducted for Todd Pacific Shipyards (Todd) in support of the Superfund Remedial Action scope for the Todd Shipyards Sediment Operable Unit (TSSOU).

Introduction

Construction of replacement structures demolished to facilitate sediment cleanup was anticipated to be finished by the end of the in-water work window (February 15th, 2007). However, due to delays in material delivery, final construction could have potentially occurred past the in-water work window, although it did not. As a contingency, Todd implemented a Fish Monitoring Plan to support a request for an extension of the in-water construction window to March 1st, if necessary.

The Fish Monitoring Plan developed for this project was based on a tiered approach and was similar to the Fish Monitoring Plan approved and implemented at the TSSOU in February 2005 (Snider 2007). The 2007 plan was submitted to the United States Environmental Protection Agency (USEPA), National Oceanic and Atmospheric Administration (NOAA) and Washington Department of Fish and Wildlife (WDFW) in January 2007. The tiers were based on the catch per unit of effort of Chinook salmon and Bull Trout. Fish monitoring was implemented to determine the presence/absence and abundance of ESA listed Chinook salmon (*Oncorhynchus tshawytcha*) and Bull Trout (*Salvelinus confluentus*) at the Turning Basin and West Waterway (if necessary).

Todd ultimately finished in-water construction on February 11, 2007 within the in-water construction window. Therefore, TAI conducted two Level 1 sampling events at the Turning Basin on February 5th and 9th and did not need to initiate Level 2 monitoring.

Methods

Level 1 sampling occurred at the Turning Basin located at river mile 5.5 on the Duwamish River. This site was used as an indicator for the beginning of the juvenile Chinook salmon outmigration. Three non-overlapping beach seine sets were conducted for each sampling date at the Turning Basin (February 5 and February 9, 2007).

TAI used a Puget Sound Protocol beach seine set from a 17-foot Boston Whaler to capture fish. Fish were identified to species, fork length measured, and released. TAI also determined if juvenile salmon were of hatchery origin by examining for adipose fin clips.

Results

No Bull Trout were caught during either sample dates. One wild juvenile Chinook (40 mm FL) was caught on February 5 during the third set, and one hatchery jack Chinook (423 mm FL) was caught during the second set on February 9 (Figure 1). The Catch per Unit Effort (CPUE) for Chinook salmon on both sampling dates was well below the 100 Chinook per seine criteria for initiating Level 2 monitoring (Table 1).

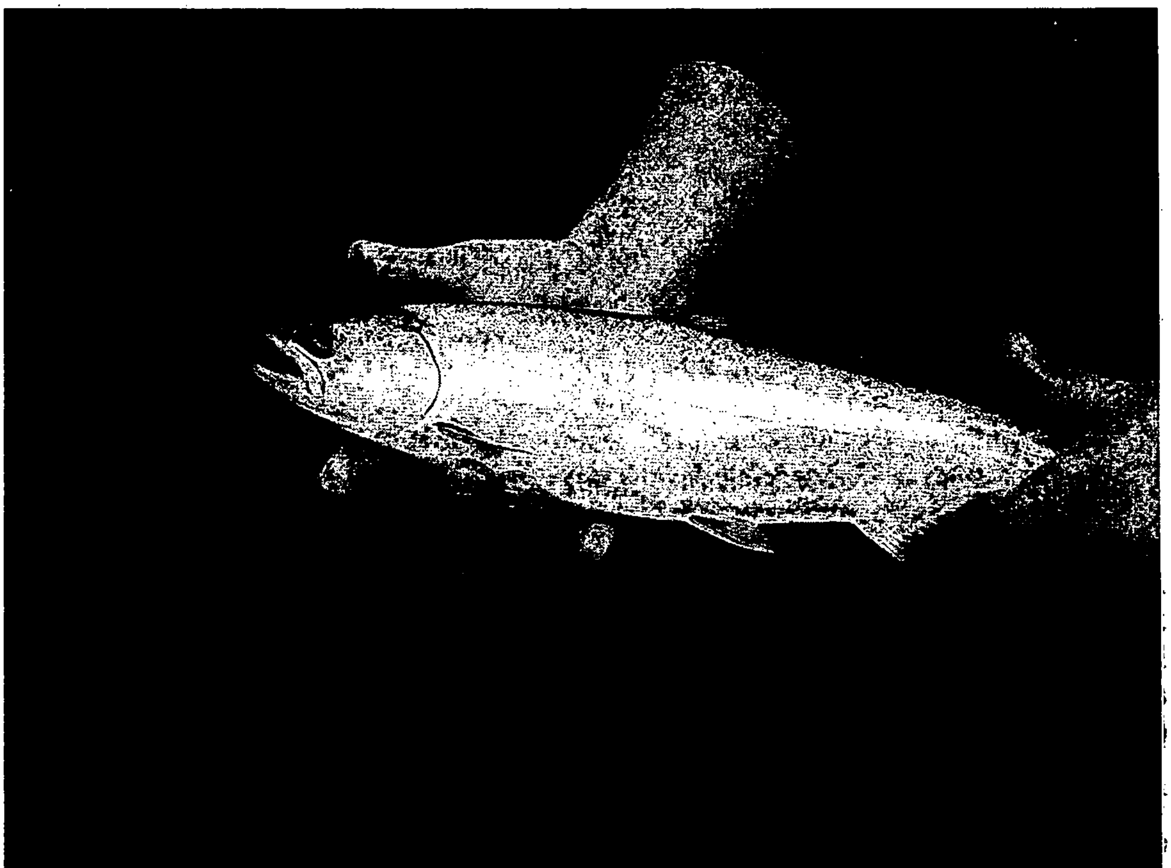


Figure 1. Hatchery jack Chinook salmon caught at the Turning Basin on February 9, 2007.

Table 1. Catch per Unit Effort (CPUE) for Chinook Salmon and Bull Trout.

Date	Site	CPUE – Chinook	CPUE – Bull Trout
February 5th	Turning Basin	0.33	0
February 9th	Turning Basin	0.33	0

Bycatch on February 5 included: starry flounder, whitefish, staghorn sculpin, sucker sp., and threespine stickleback. Bycatch on February 9 included: surf smelt, juvenile surf smelt, starry flounder, staghorn sculpin, juvenile sucker sp., and threespine stickleback.

Summary

TAI conducted two Level 1 beach seining events at the Turning Basin during early February as a contingency for Todd to extend their in-water work window in the TSSOU. No threshold exceedances occurred during the Level 1 fish monitoring events and therefore did not trigger Level 2 monitoring. Furthermore, Todd completed all in-water work within the in-water construction fish window by February 11th effectively ceasing any continued implementation of the Fish Monitoring Plan.

Appendix D

Remedial Action Completion Report

Todd Shipyards
Sediment Operable Unit

Appendix D
Northeast Shoreline in SMA 2 Design Modification, Permanent Sediment Cap

FINAL

Northeast Shoreline in SMA 2 Design Modification, Permanent Sediment Cap

Todd Shipyards
Sediment Operable Unit

Prepared for
Todd Pacific Shipyards Corporation

Prepared by
FLOYD | SNIDER

July 27, 2007

FINAL

Table of Contents

List of Tables

List of Figures

List of Attachments

1.0 Northeast Shoreline in SMA 2

1.1 INTRODUCTION

The original design for the Northeast Shoreline included a full removal of contaminants via mechanical dredging and subsequent placement of fill to allow for shoreline protection while maintaining existing shallow aquatic habitat.

Dredging was conducted to the maximum extent possible given the slope stability constraints. However, at two progress sampling locations in Sediment Management Area (SMA) 2, the Sediment Quality Standards (SQS) chemical compliance criteria could not be met. Additional dredging to remove the remaining contaminated material was not possible.

Todd Pacific Shipyards (Todd) and the United States Environmental Protection Agency (USEPA) decided to alter the design for the planned shoreline fill such that the fill would function appropriately as a permanent containment cap. At the time that this decision was made, shore protection riprap had already been placed above –5 feet mean lower low water (MLLW) in SMA 1. It was determined that all other areas of the shoreline fill would be constructed such that a 2–foot minimum isolation layer of sandy material would be placed below the planned 3-foot riprap layer. The 2-foot sand layer would be specified to match the requirements of the isolation layer designed for the adjacent Lockheed Shipyard Sediment Operable Unit (LSSOU), as the LSSOU cap design was approved for containment of similar contaminants of concern (COCs).

Additional sampling to more fully characterize the area was implemented concurrently with implementation of the shoreline fill design change. It was decided that the sampling results would allow Todd and USEPA to designate the area exceeding cleanup criteria, based on which that area of the shoreline fill would be defined as a permanent containment cap. Additionally, the additional characterization data would be used to verify that the constructed shoreline fill section would be adequate to provide the required cap functions.

Evaluation of the additional characterization data concludes that the eastern portion of SMA 2, approximately 0.34 acres of the 1.4-acre shoreline area, requires containment with a permanent sediment cap. Additionally, comparison of the additional shoreline characterization data to the data used in the LSSOU sediment cap design concludes that the sediment cap has been constructed to adequately provide chemical containment of contaminants exceeding the Todd Shipyards Sediment Operable Unit (TSSOU) compliance criteria. Information supporting these conclusions is presented below.

1.2 SHORELINE FILL DESIGN CHANGE SUMMARY

All areas of shoreline fill (with the exception of the zone of SMA 1 above –5 feet MLLW) were redesigned to meet a cross-section appropriate for a permanent shoreline containment cap. The cross-section was specified to match the minimum requirements of the LSSOU containment cap. The shoreline fill cross-section constructed on the TSSOU Northeast Shoreline includes the following layers:

- Isolation Layer: a minimum of 2 feet of gravelly sand placed on the post-dredge surface that physically isolates sediment contaminants and allows for attenuation of dissolved contaminants through adsorption and tidal flushing.
- Armor Layer: a minimum of 3 feet of light loose riprap placed on the gravelly sand to protect the isolation layer from erosion, also providing additional physical attenuation of dissolved contaminants through tidal flushing.
- Habitat mix: Sandy, rounded gravel, placed on the riprap to fill the void spaces providing favorable substrate for aquatic organisms.

One of the original goals of the Northeast Shoreline fill was to create preferential elevations for aquatic habitat. To meet this goal, most areas of the fill cross section have well in excess of the minimum 2 feet of sand fill below the riprap armor layer. In some places, the sand is greater than 20 feet thick. Sand meeting the isolation layer grain-size specification was used in all cases.

Geotechnical analysis was performed to confirm the stability of the fill section, given location and hydrodynamic forces. This analysis concluded that based on the grain-size characteristics of the isolation layer and armor layer, the section would be stable as designed and constructed, and a separate filter layer between the isolation and armor layers was not required.

The Northeast Shoreline fill as constructed is shown in plan in Figure 3.2 and cross-section in Figures 4.1a through 4.1c. The Isolation layer grain-size specification is presented in Table D.1. The actual Isolation layer grain-size distribution is shown in Figure D.1. The area of the fill in SMA 2 where the isolation layer is the minimum 2-foot thickness is identified in Figure 3.2 and Section B-B' on Figure 4.1a.

2.0 Additional Characterization Activities

Prior to shoreline fill construction, additional characterization was conducted in the shoreline portion of SMA 2 in order to better delineate the area exceeding cleanup criteria, and collect data with which to evaluate cap effectiveness. The characterization was conducted following the sampling plan described in the Additional Characterization at Todd NE Shoreline Memo (Floyd|Snider 2004). Additional characterization activities included the collection of two sediment composite samples, one from the SMA 2 Shoreline East Area (East Area) and one from the SMA 2 Shoreline West Area (West Area), for sediment chemical analysis, biological testing, and porewater chemical analysis. The sample locations within the testing area are shown in Figure D.2. The results of the additional characterization activities are described in the following sections.

2.1 SEDIMENT BIOLOGICAL TESTING RESULTS

Two sediment composite samples (TS-TSP-010 and TS-TSP-011), each composed of four surface samples, were collected from the East and West Areas (shown in Figure D.2). Both sediment composite samples were submitted to the biological testing laboratory for bioassay testing following the procedures described in the Remedial Action Sampling and Analysis Plan (RASAP) and Quality Assurance Project Plan (QAPP; FSM 2004). The results of the bioassay testing and comparison to Sediment Management Standards (SMS) biological criteria are summarized in Table D.2. A detailed quality control evaluation of the bioassay results is provided in Attachment D.1. As shown in Table D.2, the composite sample collected from the West Area (TS-TSP-010) passed all three SQS biological tests (amphipod, larval, and polychaete); however, TS-TSP-011 collected from the East Area did not pass the SQS amphipod and larval biological tests.

2.2 SEDIMENT CHEMICAL TESTING

Both sediment composite samples (TS-TSP-010 and TS-TSP-011) were also chemically analyzed for all Record of Decision (ROD) COCs—arsenic, copper, lead, mercury, zinc, low-molecular weight polycyclic hydrocarbons (LPAHs), high-molecular weight polycyclic hydrocarbons (HPAHs), polychlorinated biphenyls (PCBs), and tributyltin (TBT)—following the sampling and analysis procedures described in the RASAP and QAPP (FSM 2004). The sediment chemistry results are shown in Table D.3. Laboratory reports of the chemical analyses are provided in Appendix A of the main report. Arsenic, copper, mercury, zinc, and PCBs were detected at concentrations exceeding the SQS in both composite samples. Lead was detected at a concentration exceeding the SQS in TS-TSP-010. PAHs and TBT concentrations were less than compliance criteria in both composite samples. These data were collected for cap design verification purposes.

2.3 SEDIMENT POREWATER TESTING

Sediment porewater samples were extracted from each TSSOU sediment composite sample using centrifugation and analyzed for ROD COCs following the analytical methods described in the RASAP and QAPP (FSM 2004).

The post-dredge surface at the Northeast Shoreline was exposed and weathered for approximately 1 month prior to sediment porewater testing. The porewater analysis is considered representative of the post-cap underlying porewater concentrations, addressing sediment, debris, seawater, and groundwater conditions.

The sediment porewater chemistry results are shown in Table D.4. Copper, PCBs, PAHs, and TBT were detected in the porewater sample collected from TS-TSP-010. Copper, lead, PAHs, and TBT were detected in the porewater sample collected from TS-TSP-011. These data were collected for cap design verification purposes.

3.0 Area Requiring Permanent Sediment Cap

In order to evaluate the status and protectiveness of the capped area, Todd and USEPA determined that the evaluation of the additional characterization results would be conducted in a tiered manner following the process shown in Figure D.3. The process first involved evaluating the bioassay results. Where bioassay testing results indicated exceedances of SMS criteria, the bulk sediment and porewater chemistry would be compared to the values used in the LSSOU cap attenuation model to verify the cap design would be adequate for chemical containment.

The results of the biological testing indicate that the West Area meets the requirements of SQS biological compliance criteria and no further action is required; however, the East Area does not meet the SMS criteria for either biological or chemical criteria. Therefore, it was concluded that the shoreline fill in the 0.34-acre East Area would be defined as a permanent sediment cap. The following sections verify that the shoreline fill constructed in this area will effectively provide physical and chemical containment of the contaminants left in place exceeding cleanup criteria.

3.1 CAP DESIGN VERIFICATION

Following the bioassay evaluation that determined the SMA 2 East Area required permanent capping, the bulk sediment and porewater chemistry for the dredged surface at the SMA 2 East Area were compared to the input values characterizing the dredged surface used in the LSSOU cap attenuation model. This comparison was performed to verify that the shoreline fill section constructed at the TSSOU will function effectively as a permanent cap.

3.2 LSSOU SEDIMENT CAP DESIGN

The LSSOU sediment cap was designed to provide both physical isolation of sediment contaminants and natural attenuation of dissolved contaminants (via adsorption and dilution) such that contaminant levels at the surface of the cap would not exceed Washington State marine chronic water quality criteria. The originally approved LSSOU cap design is described in detail in the Final Remedial Design Report for the LSSOU (Hart Crowser 2003). The LSSOU cap as originally designed consisted of a four layer system, including a 2-foot thick isolation layer of gravelly sand; a filter layer; armor layer, and habitat mix.

The isolation layer was designed to provide the required chemical attenuation. The required thickness and grain size of the isolation layer was based on the results of two models: a chemical attenuation model and a physical attenuation model. The chemical attenuation model was used to predict advective and dispersive flux through the cap, accounting for retardation of contaminants due to adsorption. The results of the chemical attenuation model were used to predict the concentrations of dissolved contaminants exiting the top of the isolation layer, as well as the potential for recontamination of the top of the cap surface (fine-grained sediment naturally depositing on the surface of the riprap). The physical attenuation model is a mass balance model which was used to evaluate the effect of tidal flushing on dissolved contaminants. The results of the physical attenuation model were used to predict the reduction in dissolved chemical concentrations (predicted by the chemical attenuation model) due to mixing with surface water prior to exiting the top of the isolation layer and the riprap.

Arsenic and lead were the metals selected for the modeling effort based on the high leaching potential of these compounds (with arsenic being the highest). The LSSOU cap design and modeling effort was performed before any dredging was conducted at the LSSOU site. To represent the quality of the dredged surface, a sediment composite sample was collected at the post-dredge depth from an under-pier area within the LSSOU. Bulk chemistry was analyzed for the composite sample, and the post-dredge porewater quality was conservatively estimated by performing a Sediment Batch Leach Test (SBLT) on the collected material.

The results of the LSSOU modeling indicated that 2 feet of a gravelly sand isolation layer was sufficient to reduce dissolved contaminants to concentrations less than water quality criteria and that the concentrations of these COCs in sediment at the top of the cap surface (fine-grained sediment naturally depositing on the surface of the riprap) would be less than SQS chemical criteria. The grain-size specification for the LSSOU isolation layer is included in Table D.5

3.3 CAP DESIGN COMPARISON

Because the isolation layer constructed at the Northeast Shoreline met or exceeded the requirements of the LSSOU isolation layer, it was determined that the effectiveness of the TSSOU Northeast Shoreline cap could be verified through comparison of the bulk sediment and porewater values collected from the Todd post-dredge surface with the similar values used as input to the LSSOU modeling.

3.3.1 Sediment Chemistry Comparison

First the sediment composite results for the East Area (TS-TSP-011) were compared to the chemistry results for the under-pier sediment composite sample used in the LSSOU modeling. The LSSOU composite sample was comprised of sediment (up to 5 feet below mudline) collected from under-pier areas (LM-U-Comp). Using this sample, a leach test was performed to determine porewater input values for cap modeling.

The TS-TSP-011 and LM-U-Comp sediment chemistry results are shown in Table D.6. As shown in Table D.6, only metal results exist for the LM-U-Comp sample for comparison to TS-TSP-011. SQS exceedance ratios are also presented in Table D.6. In general, concentrations of arsenic and zinc measured at the TSSOU post-dredge surface in TS-TSP-011 sediments were around 1.5 times greater than concentrations found in LM-U-Comp. The mercury concentration in TS-TSP-011 sediments was approximately 3 times greater than that measured in LM-U-Comp. Concentrations of copper and lead in TS-TSP-011 sediments were comparable to those measured in LM-U-Comp.

Because the sediment chemistry concentrations for the TSSOU post-dredge surface exceeded the concentrations in the LSSOU composite sample, the next step in the tiered evaluation was taken to compare the porewater input values.

3.3.2 Porewater Chemistry Comparison

The porewater results from TS-TSP-011 were compared to the chemistry results for the under-pier sediment composite leachate collected during the LSSOU SBLT. The LSSOU SBLT concentrations were used in the cap modeling to represent the quality of porewater at the post-dredged surface.

The TS-TSP-011 porewater and SBLT leachate chemistry results are shown in Table D.7. As shown in Table D.7, only LSSOU leachate metals concentrations exist for comparison to the TS-TSP-011 porewater chemistry. Arsenic concentrations measured in the LSSOU leachate are much greater than those measured in the TS-TSP-011 porewater sample, with arsenic detected at 210 ppb (µg/L) in the LSSOU leachate while arsenic was not detected in the TS-TSP-011 porewater sample. In general, concentrations of copper and lead were similar in both the LSSOU leachate and the TS-TSP-011 porewater sample. Only minor exceedances of Washington State ambient water quality standards (both acute and chronic) were measured for copper in the TS-TSP-011 porewater sample; however, both arsenic and copper concentrations measured in the LSSOU leachate exceeded the acute and chronic water quality standards, with lead exceeding the chronic (lower) criteria.

Low or non-detect metals concentrations in the porewater sample from TS-TSP-011, despite elevated concentrations of metals in the bulk sediment, can be explained by the presence of abrasive grit blast (AGB) and low metals mobility associated with this material. It is reasonable to assume that the post-dredge sediment surface at the Todd Northeast Shoreline would contain a significant amount of AGB, as clean and spent blast grit had been stored adjacent to the Northeast Shoreline in the history of the shipyard, and AGB was determined present in predominant amounts at many locations on the Northeast Shoreline in the remedial investigation. Published Toxicity Characteristic Leaching Procedure (TCLP) results for AGB show that metals are tightly bound to the solid matrix of the AGB, and do not leach into porewater at significant concentrations. AGB consists of metal slag, which can contain relatively high metals concentrations yet have low metals mobility because the metals are bound up in a glassy mineral matrix produced during slag cooling. While AGB may be a contributor to metals contamination at LSSOU, arsenic may have additional sources at the LSSOU that may result in a higher arsenic mobility.

To confirm the assumptions stated above, a comparison of the physical and chemical characteristics of the East Area composite sample to the physical and chemical characteristics that define AGB was performed. As defined by USEPA in the 2003 Explanation of Significant Differences (ESD; USEPA 2003), AGB can be identified by the following:

- Visual identification, *or*
- Physical and chemical evidence:
    - Grain size of the material is greater than or equal to 50 percent coarse material typically associated with spent grit blast (i.e., 0.15 to 2.0 mm in size) *and*
    - Chemical evidence (*two or more of the following*):
        - Copper concentration greater than the cleanup screening level (CSL) of 390 mg/kg
        - Zinc concentration greater than the CSL of 960 mg/kg
        - Arsenic concentration greater than the CSL of 93 mg/kg

AGB was not visually identified in the TS-TSP-011 composite sample. However, as shown in Figure D.4, at least 50 percent of the grain-size fraction of the sample falls within the 0.15 mm to

2.0 mm particle size range. Additionally, the copper, zinc, and arsenic sediment concentrations do exceed the CSL. Therefore, the grain-size distribution and chemistry results for TS-TSP-011 do indicate the presence of AGB per the USEPA definition.

The porewater evaluation and comparison concluded the following:

- Although sediment chemistry of the post-dredge composite sample included multiple CSL exceedances for metals, this sediment (now contained below the shoreline fill cap) will not leach dissolved contamination at levels of concern, as indicated by the porewater analysis. The low or non-detect metals concentrations in the porewater, despite elevated concentrations of metals in the bulk sediment, can be explained by the presence of AGB and low metals mobility associated with this material.
- The porewater chemical concentrations from the TSSOU Northeast Shoreline post-dredged surface are lower than the porewater concentrations used in the LSSOU cap modeling. Therefore construction of a containment cap meeting or exceeding LSSOU cap design requirements would be protective.

3.4 CAP DESIGN VERIFICATION RESULTS

Following the maximum extent of shoreline dredging in SMA 2, progress samples of the post-dredge sediment surface indicated that contamination at levels greater than cleanup criteria remained.

A two-pronged approach was implemented. Additional characterization was conducted on the post-dredge surface, including bioassay analysis, to delineate the area that would need permanent capping. After an approximate 8-week sampling and analytical duration, the supplemental characterization of the post-dredge surface in SMA 2 indicated that the 0.34 acre east area required permanent capping to isolate contaminants that could not be removed through dredging.

Before results could be obtained from the supplemental characterization, Todd and USEPA decided that the shoreline fill section constructed throughout the SMAs 1 and 2 shoreline areas would be altered to match the design requirements for the sediment cap at the adjacent LSSOU, due to similarity in contaminant type and site history. The shoreline fill section constructed at the Todd Northeast Shoreline was constructed with a minimum 2-foot thick gravelly sand isolation layer below the riprap armor layer. Material used for the isolation layer met the requirements for isolation layer grain-size specified in the LSSOU cap design modeling. The isolation layer thickness constructed at the TSSOU Northeast Shoreline meets the minimum thickness requirements of the LSSOU cap design, but over the majority of the shoreline, substantially exceeds the minimum thickness.

To be effective as a permanent cap, the shoreline fill section must both isolate underlying sediments in perpetuity, and attenuate dissolved contamination such that cleanup criteria is met at the cap surface. Geotechnical design of the shoreline fill at the TSSOU confirms that the fill has been constructed in a manner that will maintain permanent physical stability and isolation given the hydrodynamic forces at the site. The location of the permanent sediment cap at the Site is shown in Figure 5.1. The post-remediation bathymetry for the capped area is shown in detail in Figure 4.2b. In the final Operations. Maintenance, and Monitoring (OMMP) plan for the site, Todd will commit to implementation of institutional controls and maintenance of the riprap surface to ensure that the fill area remains in place and is not eroded or otherwise disturbed. A short summary of the OMMP requirements and the institutional controls for the permanent sediment cap is provided in Section 4.0.

The LSSOU cap design modeling evaluated transport of dissolved contamination through the cap. The TSSOU shoreline conditions fall well within input parameters used for the LSSOU model, both for the physical characteristics of the isolation layer and for the chemical characteristics of the dissolved contamination. The isolation layer used in the TSSOU shoreline fill matches the grain-size specification in the LSSOU model, and meets or significantly exceeds the specified thickness in all locations. Porewater chemistry representative of the TSSOU dissolved contamination conditions is significantly lower than the porewater chemistry inputs in the LSSOU model. Additionally, in several cases, TSSOU porewater chemistry meets ambient water quality criteria without additional attenuation. Therefore it can be concluded that the Northeast Shoreline fill constructed at the TSSOU will be effective as a permanent cap for the 0.34-acre area where a permanent cap is required.

4.0 Long-Term Monitoring and Maintenance of the Sediment Cap

This section describes the long-term monitoring and maintenance activities for the permanent sediment cap, as well as the institutional controls to be implemented. The location of the sediment cap relative to permanent upland survey monuments is shown in Figure 5.1 of the Remedial Action Completion Report. Coordinates at each of the four corners of the permanent sediment cap are also provided on the figure to provide additional information on the cap location. Detailed requirements and specifications for long-term, post-construction maintenance and monitoring activities at the Northeast Shoreline Sediment Cap are presented in the TSSOU OMMP (Floyd|Snider 2007).

4.1 MONITORING AND MAINTENANCE

4.1.1 Monitoring Procedures

Physical integrity monitoring of the permanent Northeast Shoreline Sediment Cap will be performed to determine whether the cap armoring remains in place. The monitoring schedule is discussed in Section 4.1.2. Monitoring will consist of a physical integrity baseline survey and follow-on physical integrity monitoring surveys along a transect perpendicular to the shoreline across the cap area. The survey will include surveyor/diver observation and recording of the substrate conditions along the transect to verify the presence of riprap.

If riprap is not observed or has eroded over a portion of the transect, additional transects will be surveyed to delineate the extent of the slope where riprap is absent or eroded. Contingency actions will be performed in this area, as discussed in section 4.1.3.

A visual survey of the Northeast Shoreline Sediment Cap will occur if a major earthquake or severe storm occurs in the area. If riprap is noted to be absent or eroded in the capped area during those visual survey, transects will be surveyed to delineate the extent of the riprap loss. Contingency actions will be implemented if erosion is observed (refer to Section 4.1.3).

4.1.2 Monitoring Schedule

The first monitoring survey of the Northeast Shoreline Sediment Cap will be conducted at Year 1, occurring approximately 1 year following completion of the baseline survey. Assuming the baseline survey is completed in the fall of 2007, the first monitoring event would occur in the fall of 2008. The second and third monitoring surveys would occur during Years 2 and 4 following completion of the baseline survey, occurring in 2009 and 2011.

If riprap remains in place after the first three monitoring events, a diver survey will be performed again after six years, at Year 10. If the riprap continues to remain in place, long-term monitoring will be considered complete and no further monitoring will occur.

4.1.3 Contingency Actions in Areas Where Riprap is Absent from the Capped Area

Due to the size and weight of the riprap placed on the slope in the cap area and the potential erosive forces that may act on the slope, it is highly unlikely that cap erosion will occur. In addition, Todd has implemented institutional controls that prevent future disturbance of the capped area, as discussed in Section 4.2.

If a portion of the capped area is determined not to contain any riprap, contingency actions will first include meeting with USEPA to discuss the area in which riprap is not present, potential causes, and a design to repair the cap. In addition, the need for further sampling and analysis of the cap area and/or adjacent areas will be determined in conjunction with USEPA.

If erosion of the riprap is observed in an area, but there is not complete erosion of the riprap, contingency actions will include evaluating the potential causes of the loss of riprap and implementing additional best management practices (BMPs) to address those causes identified. The monitoring survey schedule will not be changed, but for each monitoring event the extent of the affected area will be determined to see if additional riprap losses are occurring and if additional actions need to be taken to repair the cap.

4.2 INSTITUTIONAL CONTROLS

Institutional controls will be implemented at TSSOU to prohibit activities that would disturb the Northeast Shoreline Sediment Cap. An internal Todd process memorandum will be established for the sediment cap requiring that this area be maintained in perpetuity at the TSSOU site. Long-term periodic monitoring will be required for this areas, as well as response actions if long-term performance standards are not being met, as discussed above. In addition, Todd will not excavate or dredge within these area without USEPA approval and appropriate planning.

5.0 References

Floyd|Snider. 2004. *Additional Characterization at Todd NE Shoreline*. 12 October.

Floyd Snider McCarthy, Inc. (FSM). 2004. *Final Remedial Action Work Plan, Todd Shipyards Sediment Operable Unit*. 20 May.

Hart Crowser. 2003. Final (100%) *Remedial Design Submittal, Sediment Remediation, Lockheed Shipyard No. 1, Sediment Operable Unit, Seattle, Washington*. Prepared for TRC. 24 October.

United States Environmental Protection Agency (USEPA). 2003. *Explanation of Significant Differences to the Harbor Island – Shipyard Sediment Operable Unit, Todd Shipyard Sediments, Seattle, Washington, Selected Remedial Action*. March.

Remedial Action Completion Report

Todd Shipyards
Sediment Operable Unit

Appendix D
Northeast Shoreline in SMA 2 Design Modification, Permanent Sediment Cap

Tables

FINAL

Table D.1
Isolation Layer Grain-size Specification
Todd Shipyards Sediment Operable Unit

Sieve Size	Percent Finer
3/4"	95-100
3/8"	80-90
No. 4	60-80
No. 10	30-60
No. 20	30-15
No. 40	Less than 10

Table D.2
SMA 2 Northeast Shoreline Sediment Composite Bioassay Results

Sample	Bioassay Results			SMS Bioassay Result (Pass/Fail)
	Amphipod	Juvenile Polychaete	Sediment Larval	
TS-TSP-010	Pass	Pass	Pass	Pass
TS-TSP-011	Fail-SQS	Pass	Fail-SQS	Fail

Table D.3
SMA 2 Northeast Shoreline Composite Sediment Chemistry

Parameter	Units	Compliance Criteria[1]	TS-TSP-010	TS-TSP-011
Arsenic	mg/kg	57	**320**	**250**
Copper	mg/kg	390	**821**	**592**
Lead	mg/kg	450	**774**	420
Mercury	mg/kg	0.41	**2.36**	**1.75**
Zinc	mg/kg	410	**1,990**	**1,440**
TOC	%	-	0.931	1.98
Total PCBs	mg/kg - OC	12	*	**14.6**
Total PCBs [2]	µg/kg	130	**279**	*
LPAHs	mg/kg - OC	370	*	314
LPAHs[2]	µg/kg	5,200	2910	*
HPAHs	mg/kg - OC	960	*	615
HPAHs[2]	µg/kg	12,000	10,360	*
TBT[3]	mg/kg - OC	76	*	19
TBT[4]	µg/kg	1,335	270	*

Notes:
* Sample result not compared to compliance criteria (dependent on TOC value).
1 Compliance criteria based on SQS chemical criteria per Washington State Sediment Management Standards (SMS; Chapter 173-204 WAC), unless otherwise noted.
2 Compliance criteria based on Lowest Apparent Effects Threshold (LAET) chemical criteria per "1988 Update and Evaluation of Puget Sound AET" (Barrick, Becker, Brown, Beller, and Pastorak) where total organic carbon (TOC) value is less than 1%.
3 Compliance criteria based on confirmational number stated in the 2002 Explanation of Significant Differences (ESD).
4 Compliance criteria based on the dry weight concentration will be used when the total organic carbon (TOC) value is less than 1%.
Bold indicates analytical result exceeds compliance criteria.

Table D.4
SMA 2 Northeast Shoreline Composite Sediment Samples
Porewater Chemistry

Parameters	Units	TS-TSP-010	TS-TSP-011
Metals			
Arsenic	µg/L	20 U	20 U
Copper	µg/L	6	5
Lead	µg/L	2 U	6
Mercury	µg/L	0.10 U	0.10 U
Zinc	µg/L	10 U	10 U
PCBs			
Aroclor 1016	µg/L	1.0 U	1.0 U
Aroclor 1242	µg/L	1.0 U	1.0 U
Aroclor 1248	µg/L	1.0 U	1.0 U
Aroclor 1254	µg/L	1.7	1.0 U
Aroclor 1260	µg/L	0.97 J	1.0 U
Aroclor 1221	µg/L	1.0 U	1.0 U
Aroclor 1232	µg/L	1.0 U	1.0 U
Total PCBs	µg/L	2.7 J	1.0 U
LPAHs			
Naphthalene	µg/L	0.27 B	0.40 B
Acenaphthylene	µg/L	0.10 U	0.10 U
Acenaphthene	µg/L	3.9	5.2
Fluorene	µg/L	0.98	1.9
Phenanthrene	µg/L	1.40	3.1
Anthracene	µg/L	0.49	0.87
2-Methylnaphthalene	µg/L	0.10 U	0.10 U
HPAHs			
Fluoranthene	µg/L	6.2	4.9
Pyrene	µg/L	5.4	5.8
Benzo(a)anthracene	µg/L	1.4	0.74
Chrysene	µg/L	1.4	0.91
Benzo(b)fluoranthene	µg/L	1.8	0.56

Table D.4
SMA 2 Northeast Shoreline Composite Sediment Samples
Porewater Chemistry

Parameters	Units	TS-TSP-010	TS-TSP-011
Benzo(k)fluoranthene	µg/L	1.3	0.56
Benzo(a)pyrene	µg/L	1.5	0.57
Indeno(1,2,3-cd)pyrene	µg/L	0.54	0.19
Dibenzo(a,h.)anthracene	µg/L	0.23	0.10 U
Benzo(g,h,i)perylene	µg/L	0.53	0.28
Dibenzofuran	µg/L	1.0	2.0
TBT			
TBT ion*	µg/L	0.205	0.0285
TBT Chloride	µg/L	0.23	0.032

Notes:
* Converted value; TBT ion concentration calculated by multiplying the TBT Chloride concentration by 0.89.
B Compound detected in method blank.
J The analyte was positively identified but concentration is an estimated value.
U Compound undetected at the reported concentration.

Table D.5
Isolation Layer Grain-size Specification
Lockheed Shipyard Sediment Operable Unit

Sieve Size	Percent Finer
3/4"	95-100
3/8"	80-90
No. 4	60-80
No. 10	30-60
No. 20	5-30
No. 40	Less than 5

Table D.6
Comparison of Sediment Chemical Results for TS-TSP-011 and LM-U-Comp

Parameter	Units	Compliance Criteria[1]	SQS Ratio	TS-TSP-011	SQS Ratio	LM-U-Comp (SBLT)
Arsenic	mg/kg	57	4.4	**250**	2.7	**154**
Copper	mg/kg	390	1.5	**592**	1.9	**735**
Lead	mg/kg	450	0.9	420	1.4	**622**
Mercury	mg/kg	0.41	4.3	**1.75**	1.5	**0.6**
Zinc	mg/kg	410	3.5	**1,440**	2.8	**1140**

Notes:
1 Compliance criteria based on SQS chemical criteria per Washington State Sediment Management Standards (SMS; Chapter 173-204 WAC), unless otherwise noted.
Bold indicates analytical result exceeds compliance criteria.

Table D.7
TS-TSP-011 Porewater Chemistry Comparison to LSSOU SBLT Porewater Chemistry and Water Quality Criteria

		Aquatic Life Ambient Water Quality Criteria[1]		TSSOU Porewater Sample	Lockheed SBLT Leachate Samples-Worst Case Results
Parameters	**Units**	**Acute**	**Chronic**	**TS-TSP-011**	**LM-SBLT**
Arsenic	µg/L	69	36	20 U	**210**
Copper	µg/L	4.8	3.1	**5**	**9**
Lead	µg/L	210	8.1	6	**9**
Mercury	µg/L	1.8	0.025	0.10 U	0.1 U
Zinc	µg/L	90	81	10 U	10 U

Notes:
U Compound undetected at the reported concentration.
1 WAC 173-201A, Water Quality Standards for Surface Waters of the State of Washington: aquatic life criteria for a water body of good quality (Duwamish River), unless otherwise noted.
Bold indicates analytical result exceeds compliance criteria.

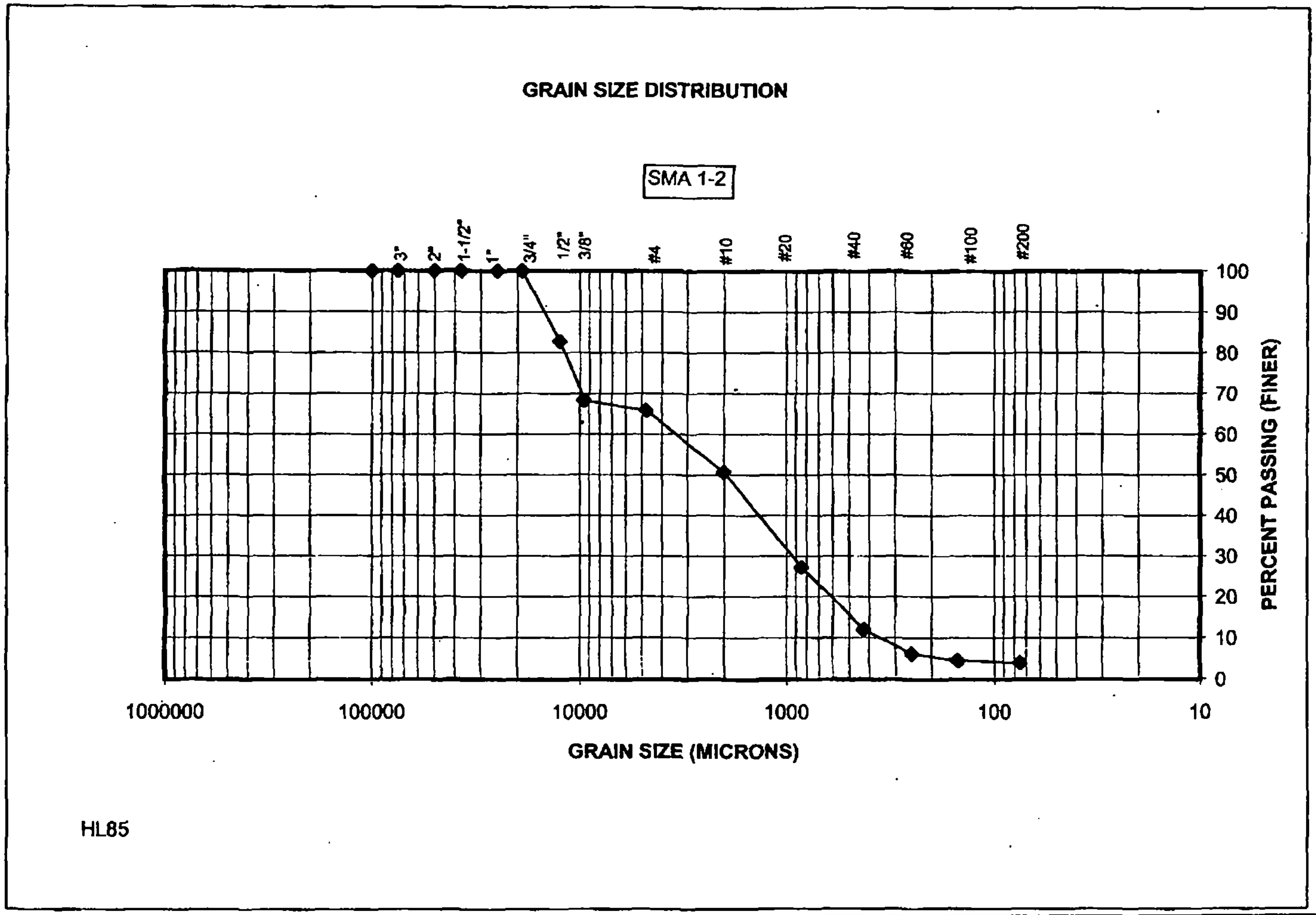
Remedial Action Completion Report

Todd Shipyards
Sediment Operable Unit

Appendix D
Northeast Shoreline in SMA 2 Design Modification, Permanent Sediment Cap

Figures

FINAL



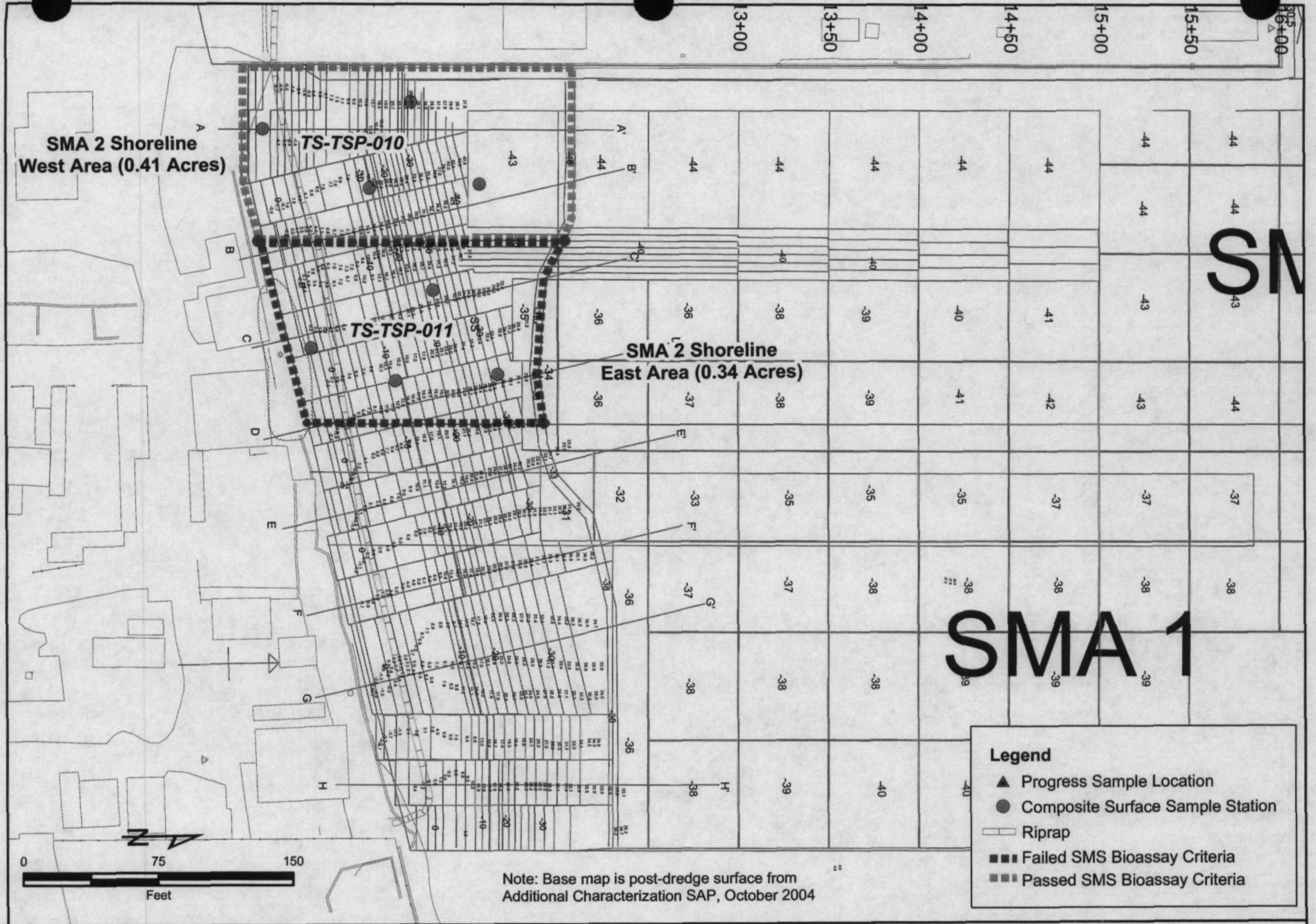
Percent Finer Than Indicated Size

Sample No.	Gravel				Sand					
Sieve Size (microns)	3/4"	1/2"	3/8"	#4	#10	#20	#40	#60	#100	#200
SMA 1-2	100.0	82.8	68.3	65.8	50.7	27.3	12.0	6.2	4.6	4.0

FLOYD | SNIDER
strategy • science • engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure D.1
Grain-size Distribution



FLOYD | SNIDER
strategy • science • engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure D.2
Northeast Shoreline SMA 2 Composite
Sample Locations

DATE: 4/3/2006 4:23:18 PM
MXD NAME: \\Sam\Data\projects\TODD-NPL\GIS\RACR - Figure C.2 SMA 2 Comp Samps.mxd

Bioassay pass? —YES— Area not defined as permanent containment cap

NO

Bulk Chemistry comparison to Lockheed Composite used for SBLT —Favorable— Lockheed model is representative of Todd conditions. Therefore Todd cap (which meets or exceeds Lockheed construction requirements) judged to be effective permanent containment cap for the represented area.

Not similar to Lockheed model input

Porewater comparison to SBLT results at Lockheed which were used to represent porewater in Lockheed cap modeling —Favorable— Lockheed model is representative of Todd conditions. Therefore Todd cap (which meets or exceeds Lockheed construction requirements) judged to be effective permanent containment cap for the represented area.

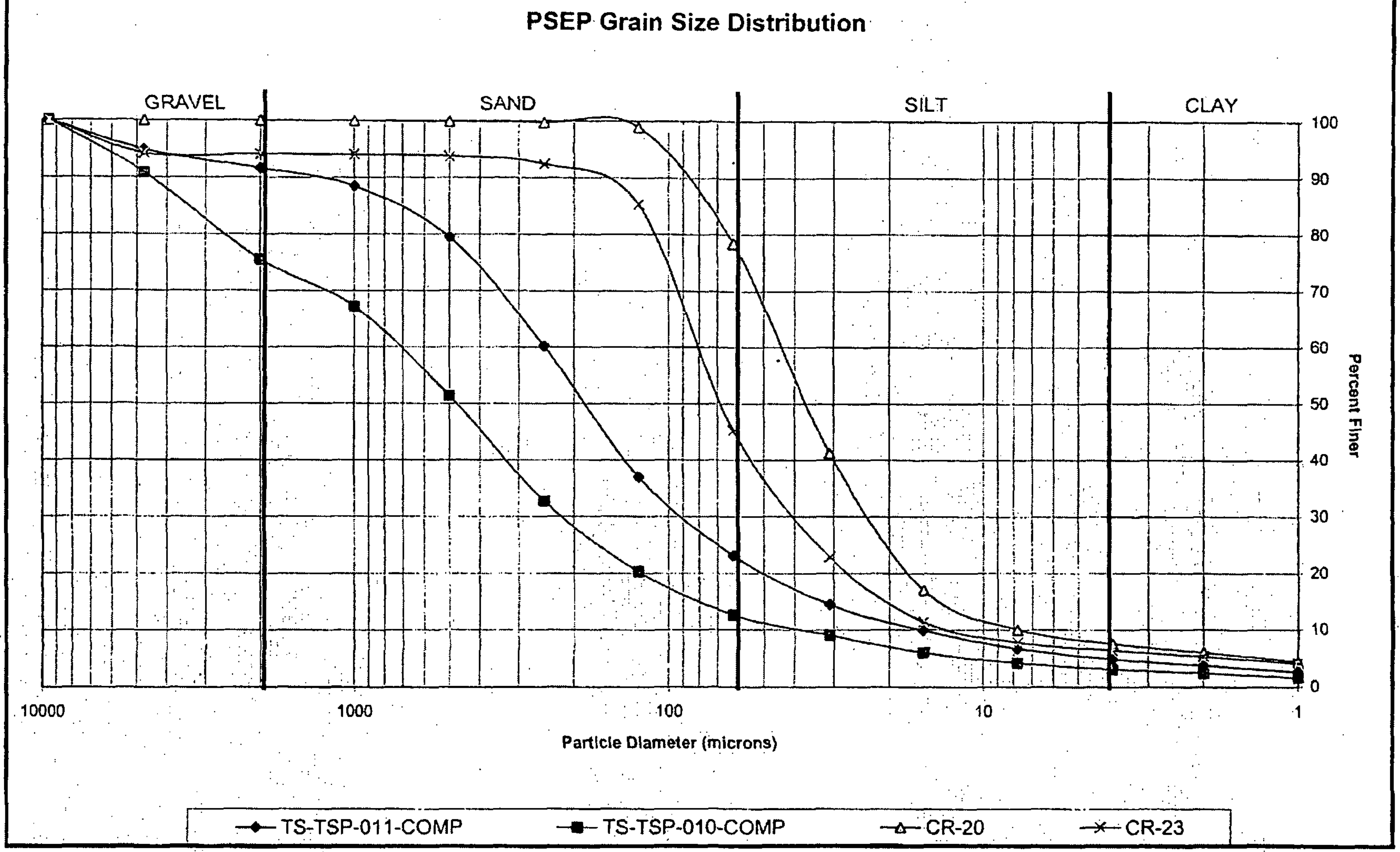
Not similar to Lockheed model input

Run site-specific cap model using porewater and calculated or assumed Kd values

TWO CLARIFYING NOTES:

1. We have reviewed the Lockheed model and determined that all model inputs are equal - sediment and porewater chemistry are the unknowns to be determined by this analysis.

2. The post-dredge shoreline surface at Todd has been exposed and weathering for approximately 1 month. Our assumption is that existing porewater analysis will be most representative of the post-cap underlying porewater concentrations, - addressing sediment, debris, seawater and groundwater conditions.



FLOYD | SNIDER
strategy • science • engineering

Remedial Action Completion Report
Todd Shipyards
Sediment Operable Unit

Figure D.4
PSEP Grain-size Distribution

Remedial Action Completion Report

Todd Shipyards
Sediment Operable Unit

Appendix D
Northeast Shoreline in SMA 2 Design Modification, Permanent Sediment Cap

Attachment D.1
Biological Testing of Composite Samples Collected in SMA 2 at Todd Shipyard

FINAL

MCS Environmental, Inc.

6505 – 216th Street SW, Suite 100
Mountlake Terrace, WA 98043
425-697-4340 (voice) • 425-697-4370 (fax)

January 18, 2005

Mr. Matthew Woltman
Floyd|Snider
83 S King Street, Suite 614
Seattle, WA 98104

Re: Biological Testing of Composite Samples Collected in SMA 2 at Todd Shipyard—Bioassay Task 4030; MCS #340001 1.006

Dear Matt:

This letter report describes the sample-collection procedures for the reference and test sediments, provides the results of the conventionals analysis, and describes the bioassay procedures and results.

SEDIMENT COLLECTION

Reference Sediment Collection for Bioassay Testing

Reference sediments were collected from Carr Inlet, Olympia, Washington; control sediments were collected from lower Yaquina Bay, Newport, Oregon, for the 10-d amphipod test. Charlie Eaton from Bio-Marine Enterprises, Seattle, Washington, collected the reference sediments from Carr Inlet. The location, date of collection, and conventional sediment parameters for the reference sediment collected from Carr Inlet are summarized in Table 1.

Sediments were collected from three reference stations in Carr Inlet. The stations were selected to provide sediments with different percentages of fine-grained sediments similar to the distribution of grain sizes seen at Todd in previous sampling. The reference areas selected were CR-20, CR-23, and MSMP-43. Sediments from station MSMP-43 were selected as the closest sediment match on the basis of the percent fines (Table 1). Sediments from MSMP-43 were used as the reference sediment for both test sediments for the full suite of bioassays.

Test Sediment Collection and Compositing

Each test sediment was a composite of sediment collected at four locations. Three of the locations were subtidal and were sampled using a 0.1-m² van Veen grab sampler (Table 2). The fourth location was in the intertidal and was sampled with a hand trowel or shovel by Floyd|Snider personnel during low tide. One to two grabs were collected at each of the subtidal stations to obtain sufficient sample material. The top 10 cm of sediment from each grab sample was collected. Sediment touching the sides of the grab was not composited. Equal amounts of sediment from each sample location were composited together. The sediment was thoroughly homogenized and placed in the sample containers. Sediments for bioassay testing were purged with nitrogen gas and held at approximately 4°C until used. Subsamples of each composite were sent to Analytical Resources, Inc., Tukwila, Washington, for analysis of conventional parameters and pore-water salinities. The results of the conventionals analysis are presented in Table 3.

BIOASSAY TESTS

Bioassay testing was conducted by EVS Environment Consultants, Vancouver, British Columbia. Seawater used in acclimation and each bioassay test vessel was marine water collected from a depth of 15 to 20 m in Burrard Inlet, Vancouver, British Columbia, filtered through a 0.5-µm filter, and UV sterilized.

Amphipod Test—The amphipod sediment bioassay is a 10-day acute/lethal test used to determine the influence of experimental sediments on amphipod survival. Sediment testing of the two composite test sediments was conducted using *Eohaustorius estuarius*. On November 12, 2004, *E. estuarius* were field collected from lower Yaquina Bay, Newport, Oregon, by Northwestern Aquatic Sciences, Newport, Oregon. Yaquina Bay sediments were collected by Northwestern Aquatic Sciences for the *Eohaustorius* bioassay negative control. Each test was also run with the appropriate positive (cadmium chloride) controls.

Juvenile Polychaete Test—The juvenile polychaete sediment bioassay is a 20-day chronic/ sublethal test used to determine the influence of experimental sediments on juvenile polychaete survival and growth. Juvenile polychaete worms (*Neanthes*) were purchased from Dr. Don Reisch, Long Beach State University, California, for use in this test. All individual organisms were of similar life stage and between 0.5 mg and 1.0 mg in weight. Upon arrival, worms were acclimated to the testing temperature for one day and then introduced to the sediment-loaded test vessels. Each test was run with the appropriate negative (silica sand) and positive (cadmium chloride) controls. Individual test vessels were fed every two days, and one-third of the overlying seawater was renewed every three days. Water renewal in negative-control and reference-sediment test vessels was on the same schedule as that for the test sediments. After 20 days control, reference, and experimental sediments were sifted and surviving individuals were recovered, rinsed in deionized water, and then dried to a constant weight at 50°C. Statistical analysis of average individual biomass and growth was done by comparing samples from the reference and experimental sediments.

Sediment Larval Test—The bivalve embryo sediment bioassay is a 48- to 96-hour mortality/ abnormal-development test used to determine the influence of experimental sediments on bivalve embryo development. The blue mussel (*Mytilus galloprovincialis*) was used for the tests. Adult blue mussels were purchased from Carlsbad Aqua Farms, Carlsbad, California.

Upon arrival at the bioassay laboratory, adult mussels were acclimated to the testing temperature and then induced to spawn using thermal and biological cues. Eggs were fertilized at the appropriate concentration and the resultant embryos were introduced into prepared testing vessels. Seawater used in acclimation and each bioassay test vessel was filtered marine water from Burrard Inlet, Vancouver, British Columbia. Each test was run with the appropriate negative (seawater) and positive (copper chloride) controls. Replicate test vessels were monitored daily for water quality. The test was terminated when 90% or more of the embryos reached the prodissoconch stage. The test was terminated by the addition of 5% buffered formalin to well-mixed aliquots from each test vessel. Determination of development stage was made microscopically.

Biological Testing Performance Criteria

The results of the bioassays are in Table 4 (amphipod), Table 5 (polychaete), and Table 6 (larval test).

The complete results of the bioassay testing, including the test protocols, are in the *PSDDA Marine Sediment Toxicity Testing Program October 2004 Sample* (see attachment). Presented below is a summary of the bioassay test results.

Amphipod Tests

The amphipod test using *Eohaustorius estuarius* was initiated November 19, 2004, on two test (TS-TSP-010COMP and TS-TSP-011COMP) and a reference sediment (MSMP-43). The following Sediment Management Standards (SMS) evaluation criteria were used to evaluate the validity of the test:

- **Negative-control performance standard**—The mortality of the amphipods in the control sediment (M_C) is less than 10% ($M_C < 10\%$).
- **Reference-sediment performance standard**—The mortality of the amphipods in the reference sediment (M_R expressed as a percent) is less than 25% ($M_R < 25\%$).

Interpretive results (Table 4) were determined using the following SMS evaluation criteria:

- **SQS**—If the absolute mortality of the amphipods in the test sediment (M_T expressed as a percent) is greater than 25% ($M_T > 25\%$ absolute), and M_T is significantly different from ($p \leq 0.05$) the reference-sediment mortality (M_R).
- **MCUL**—If M_T-$M_R > 30\%$, and M_T is significantly different from ($p \leq 0.05$) M_R.

The negative control and reference sediment met the required performance standards. Sediments from TS-TSP-010COMP passed the SMS evaluation criteria. Sediments from TS-TSP-011COMP failed to meet the SMS evaluation criteria.

Juvenile Polychaete Test

The juvenile polychaete test using *Neanthes* was initiated November 19, 2004, on two test (TS-TSP-010COMP and TS-TSP-011COMP) and a reference sediment (MSMP-43). The following SMS evaluation criteria were used to evaluate the validity of the test:

- **Negative-control performance standard**—The mortality of the polychaetes in the control sediment (M_C) is less than or equal to 10% (M_C < 10%) and the mean individual growth rate in the control (MIG_C) is greater than or equal to 0.72 ($MIG_C \geq 0.72$ mg/individual/day).

- **Reference-sediment performance standard**—The ratio of mean individual growth rate of the worms in the reference sediment (MIG_R) to the mean individual growth rate of the worms in the control sediment (MIG_C) is greater than or equal to 0.80 ($MIG_T/MIG_C \geq 0.80$).

Interpretive results (Table 5) were determined using the following SMS evaluation criteria:

- **SQS**—If the ratio of the mean individual growth rate of the worms in the test sediment (MIG_T) to the mean individual growth rate of the worms in the control sediment (MIG_C) is less than 0.70 ($MIG_T/MIG_C < 0.80$) and MIG_T is significantly different from ($p \leq 0.05$) the mean individual growth rate of the worms in the reference sediment (MIG_R).

- **MCUL**—If MIG_T/MIG_R is less than 0.50 and MIG_T is significantly different from ($p \leq 0.05$) MIG_R.

The negative control and reference sediment met the required performance standards. Sediments from TS-TSP-010COMP and TS-TSP-011COMP passed the SMS evaluation criteria.

Sediment Larval Test

The sediment larval test using *Mytilus galloprovincialis* was initiated November 9, 2004, on two test (TS-TSP-010COMP and TS-TSP-011COMP) and a reference sediment (MSMP-43). The following SMS evaluation criteria were used to evaluate the validity of the test:

- **Negative-control performance standard**—The ratio of normal larvae in the seawater control (N_C) to the initial count of larvae used to inoculate the test containers (I) is greater than or equal to 0.70 ($N_C/I \geq 0.70$).

- **Reference-sediment performance standard**—The ratio of normal larvae in the reference sediment (N_R) to the normal larvae in the seawater control (N_C) is greater than or equal to 0.65 ($N_C/N_R \geq 0.65$).

Interpretive results (Table 6) were determined using the following SMS evaluation criteria:

- **SQS**—If the ratio of seawater-control normalized normal larvae in the test sediment (N_T/N_C) to the seawater-control normalized normal larvae in the reference sediment (N_R/N_C) is less than 0.85 ($N_T/N_C \div N_R/N_C < 0.85$), and the average number of seawater-control normalized normal larvae in the test sediment (N_T/N_C) is significantly different from ($p \leq 0.10$) and less than the average number of seawater-control normalized normal larvae in the reference sediment (N_R/N_C).

- **MCUL**—If N_T/N_C divided by N_R/N_C is less than 0.70 and (N_T/N_C) is significantly different from ($p \leq 0.10$) and less than (N_R/N_C).

The negative control and reference sediment met the required performance standards. Sediments from TS-TSP-010COMP passed the SMS evaluation criteria. Sediments from TS-TSP-011COMP failed to meet the SMS evaluation criteria.

All of the bioassay tests meet the criteria for test validity. Table 7 presents a summary of the bioassay results.

Sincerely,

MCS Environmental, Inc.

Robert Gilmour
Project Biologist
r.gilmour@mcs-environmental.com

Attachments:
Tables 1 to 7
EVS Consultants, December 2004, *PSDDA Marine Sediment Toxicity Testing Program, October 2004 Sample*

Table 1 Reference Sediment Collection in Carr Inlet

Collection Date	Reference Station ID	State Plane Coordinates NAD 1983, Washington N Zone Northing	Easting	Estimated Mudline Elevation at Reference Station (ft MLLW)
10/19/2004	MSMP-43	114518	1166734	-65
10/19/2004	CR-23	126933	1183492	-47
10/19/2004	CR-20	127026	1184839	-50
	MSMP-43	CR-23	CR-20	
Conventionals	Reference	Reference	Reference	
Total Solids (%)	73.2	65.4	60.1	
Preserved Total Solids (%)	66.8	62.3	54.1	
N-Ammonia (mg-N/kg)	16.4	10.8	16.2	
Sulfide (mg/kg)	<3.2U	250	200	
Total Organic Carbon (%)	0.73	0.6	0.64	
Pore-Water Salinity (g/kg)	29.2	29.4	29.2	
Percent Fines (%< 63 μ)	7.4	45.2	78.5	

Table 2 Test Sediment Collection at TODD Shipyard

Collection Date	Station ID	State Plane Coordinates NAD 1983, Washington N Zone		Estimated Mudline Elevation at Station (ft MLLW)	Composite Designation
		Northing	Easting		
10/21/2004	TSP-02-10B	217854	1264870	-26	TS-TSP-010COMP
10/21/2004	TSP-02-10B	217857	1264887	-25	TS-TSP-010COMP
10/21/2004	TSP-02-10C	217876	1264925	-32	TS-TSP-010COMP
10/21/2004	TSP-02-10C	217902	1264919	-40	TS-TSP-010COMP
10/21/2004	TSP-02-10D	217896	1264919	-41	TS-TSP-010COMP
10/21/2004	TSP-02-11B	217885	1264971	-29	TS-TSP-011COMP
10/21/2004	TSP-02-11B	217888	1264955	-37	TS-TSP-011COMP
10/21/2004	TSP-02-11C	217875	1265031	-18	TS-TSP-011COMP
10/21/2004	TSP-02-11C	217878	1265036	-18	TS-TSP-011COMP
10/21/2004	TSP-02-11D	217915	1265026	-32	TS-TSP-011COMP
10/21/2004	TSP-02-11D	217909	1265024	-30	TS-TSP-011COMP

Table 3 Results of Conventional Analyses for Test Sediments

Collection Date	Laboratory Sample ID Numbers	
10/21/2004	TS-TSP-010-COMP	TS-TSP-011-COMP
Conventionals	Test	Test
Total Solids (%)	75.4	68.7
Preserved Total Solids (%)	72.9	64.6
N-Ammonia (mg-N/kg)	1.65	3.21
Sulfide (mg/kg)	200	390
Total Organic Carbon (%)	0.931	1.98
Pore-Water Salinity (g/kg)	28.7	29.2
Percent Fines (%< 63 µ)	12.6	23.1

Table 4 Results of Amphipod Sediment Bioassay (Percent Mortality Endpoint) Conducted in November 2004

Test Species	Sample ID No.	Percent Fines	Location	Replicate (Percent Mortality) 1	2	3	4	5	Mean	Sediment Management Standards Evaluation Endpoints: SQS M_T >25% and M_T vs M_R SD (p = 0.05)	MCUL M_T-M_R >30% and M_T vs M_R SD (p = 0.05)
Eohaustorius			Control	0	5	0	0	0	1		
	TS-TSP-10comp	12.6	Test	15	10	10	15	5	11		
	TS-TSP-11comp	23.1	Test	50	45	30	25	30	36	x	
	MSMP-43	7.4	Reference	25	10	0	0	0	7		

SD: Statistically different
M: Percent mortality
Subscripts: R = reference sediment, C = negative control, T = test sediment
X: Bioassay exceeds the criteria

Table 5 Results of Juvenile Polychaete Sediment Bioassays (Mean Individual Growth Rate Endpoint) Conducted in November 2004

Test Species	Sample ID No.	Percent Fines	Location	Replicate (Mean Individual Growth Rate [mg/ind/d]) 1	2	3	4	5	Mean	Sediment Management Standards Interpretation Endpoints: SQS $MIG_T/MIG_R < 0.70$ and MIG_T vs MIG_R SD ($p = 0.05$)	MCUL $MIG_T/MIG_R < 0.50$ and MIG_T vs MIG_R SD ($p = 0.05$)
Neanthes			Control	0.93	0.82	0.69	0.99	1.34	0.95		
	TS-TSP-10comp	12.6	Test	0.83	0.80	0.97	0.99	0.82	0.88		
	TS-TSP-11comp	23.1	Test	0.82	1.07	0.87	0.72	1.27	0.95		
	MSMP-43	7.4	Reference	0.97	1.12	0.85	1.29	0.75	1.00		

SD: Statistically different
MIG: Mean individual growth rate (mg/individual/day)
Subscripts: R = reference sediment, C = negative control, T = test sediment
X: Bioassay exceeds the criteria

Table 6 Results of Sediment Larval Bioassay (Normality Endpoint) Conducted in November 2004

Test Species	Sample ID No.	Percent Fines	Location	Replicate (Raw Counts of Normal Larvae) 1	2	3	4	5	Mean	Sediment Management Standards Interpretation Endpoints: SQS $N_T/N_C \div NR/NC < 0.85$ and N_T/N_C vs N_R/N_C SD ($p = 0.10$)	MCUL NT/NC¸NR/NC <0.70 and N_T/N_C vs N_R/N_C SD ($p = 0.10$)
Mytilus galloprovincialis			Control	320	309	319	325	347	324.00		
	TS-TSP-10comp	12.6	Test	252	274	273	250	280	265.80		
	TS-TSP-11comp	23.1	Test	203	197	183	180	178	188.20	X	
	MSMP-43	7.4	Reference	282	257	273	274	246	266.40		

SD: Statistically different
N: Counts of normal larvae
Subscripts: R = reference sediment, C = negative control, T = test sediment
X: Bioassay exceeds the criteria

Table 7 Summary of Biological Testing Results by Sample ID

Sample	Bioassay Results			Bioassay Testing Result
	Amphipod	Juvenile Polychaete	Sediment Larval	
TS-TSP-10comp	Pass	Pass	Pass	Pass
TS-TSP-11comp	SQS	Pass	SQS	Fail

December 2004

Laboratory Report

MCS Environmental Inc.
PSDDA Marine Sediment
Toxicity Testing Program
October 2004 Sample

PREPARED FOR:

MCS Environmental Inc.

6505 216th St. SW, Suite 100
Mountlake Terrace, WA

PREPARED BY:

EVS environment consultants
A Member of the Golder Group of Companies

North Vancouver, BC

The Marine Sediment Toxicity Testing Laboratory Report is included in the Appendix A CD